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OUR TWO BRAINS.

BY RICHARD A. PROCTOR.

THAT we have two brains may be said to be as certain as that we have two eyes, two ears, and two nostrils. Whether the two brains—I use the expression purposely, instead of the usual expression, the two hemispheres of the brain—act as independently of each other as the two eyes or the two ears may be disputed. It may be maintained by some that though they *can* thus act independently, should occasion arise, the two halves of the brain, as a rule, work not only as one but as parts of a single organ. Others may hold (though the evidence is strong against this extreme view) that one brain alone of the two can never suffice for the process of reasoning. Others again may believe that the two brains are absolutely independent organs, a view as extreme on the other side. But whatever opinion may be held as to the action of the two brains, there can be no question as to their existence in all normal cases. That the two brains are connected or associated together, is no doubt true. So are the two eyes connected by the optic commissure. But we do not speak of the two eyes as one organ, though they serve a single sense. Even less can we speak of the two brains as a single organ, when we find no clear evidence even that they do the same work. If each does or can do the same work, independently of the other, they must be held to be distinct organs even as the right eye is distinct from the left, when both work together in ordinary vision. If the two brains do different work, they are still more obviously distinct organs,—even as I, for instance, more definitely recognise the duality of my eyes than most persons, because, unlike most, I use one eye for distant vision and the other for fine work at short focal ranges.

Of course a case might be made out for the oneness of the brain as an organ, despite its duality of form, if it could be shown that the individuality of the owner of the brain depended wholly and solely on the co-existence, in a complete state, of both hemispheres of the cerebrum (or of both *cerebra*, as one should more correctly say). Even if the two eyes, distinct though they are in appearance, were found to be severally essential to vision, we should be obliged to regard them as a single organ, much as we regard the upper arm and the lower arm as forming a single limb. Nothing short of this, however,—and we have no evidence even approaching this,—could compel us to reject the doctrine of the duality of the brain.

I propose to consider some of the evidence which led Dr. A. L. Wigan to definitely enunciate this doctrine, suspected apparently by Dr. Holland and others before Wigan's time, but not clearly perceived or stated till he wrote his work, now I believe out of print, "The Duality of Mind." I would, however, at the outset, point out how interesting, nay important, the inquiry is. How many moral problems of difficulty find their solution if we recognise in each one of us two minds, and in effect two wills, working it may be in harmony together at all times, or only in harmony when the body is in sound health, or one usually holding sway over the other, or alternating in their influence on conduct, or one it may be diseased and only held in restraint by the other from guiding the man astray! Again, how many interesting mental problems appear in a new light when thus viewed! We have to consider two memories, usually no doubt synchronising in their action, but not necessarily working thus simultaneously; two attentions; two reasoning processes; and so forth. Again, the two brains may differ in their physical powers, even as one arm may be stronger than the other, one eye more sensitive than the other to light, more easily wearied, and so on. Such considerations are full of interest, and may throw important light on mental phenomena: but they are most important in their bearing on character and conduct.

I might here occupy much space with a description (in outline) of the human brain as analysed and interpreted in our time. But for my present purpose this is unnecessary. The following points, only, need here be specially noted:—

If a vertical section be supposed to be taken through the middle of the head from front to back, that is so as to divide it (through the middle of the chin, nose, forehead, crown, and nape of the neck) into right and left portions, this section will divide the whole nervous mass within the skull into two symmetrical halves. Each part on one side of the plane of division has its counterpart on the other side, in the same way that each bone, muscle, tendon, fibre, and nerve in the right arm has its counterpart in the left arm. There is not *perfect* symmetry, nor *exact* correspondence, any more than in the case of the two arms. In some cases there is a marked want of symmetry, just as in some men we see one arm much better developed than the other: but such abnormal cases do not affect the general truth that the right and left sides of the outer head are symmetrical, and that the right and left arms correspond to each other.

Again, the principal parts of the cerebral mass, though thus double, are connected across the median plane by medullary bands called commissures, by which each part on one side is united to its fellow on the other side. Thus the great hemispheres (which in reality are not much more than quarter spheres) are connected by the "great commissure" called the *corpus callosum;* the halves of the *cerebellum* (or little brain, occupying the lower and hinder part of the cavity of the cranium) are connected by the *pons Varolii* or *tuber annulare;* and there are other commissures of smaller size. This connection of the corresponding parts of the two side brains no more combines them into a single brain than the two arms are made one by being attached to the same body.

Between the two so-called hemispheres of the brain there lies above a scythe-shaped extension of the membranous covering called the *dura mater;* the point of the scythe is

forward, and its median plane is of course vertical. It is called the *falx cerebri*. A large lateral expansion of the *falx*—called the *tentorium*—separates the posterior lobes of the cerebrum from the cerebellum, extending over the latter like a vaulted floor. It protects the cerebellum from the pressure of the hinder part of the cerebrum.* The central hemispheres are separated below by two cavities termed the *lateral ventricles*. There are other smaller cavities called respectively the *third ventricle*, and the *ventricle of the cerebellum*. The last-named is of considerable extent, and occupies the space between the cerebrum, the commissure of the cerebrum, and the *medulla oblongata*, the portions of the nervous mass lying at the base of the cranial cavity, between the cerebrum and the cerebellum.

It should be added that from the upper surface of the convolutions, fibres descend to the *medulla oblongata*, where they form the *corpora pyramidalia* and decussate or cross over from one side to the other. This interesting fact was first established by Drs. Gall and Spurzheim. It follows that the right brain rules the left side of the body, and the left brain the right side. In agreement with this is the fact that if one side of the brain suffers it is the opposite side of the body which is alone affected.

I have said so much respecting the parts of the brain rather that the cases which will have presently to be quoted may be fully understood, than with any idea of giving even in outline an account of the exceedingly complex structure which appears to regulate thought, sensation, and motion.

We have now to consider the evidence tending to show that each of the so-called "hemispheres of the brain" is an independent organ of thought, in the same sense that each eye is an independent organ of vision.

The first point to be noted is that one side of the brain may suffer the most serious mischief, or even be destroyed, without any marked injury to the mental functions.

Dr. Wigan mentions the following case as that which first attracted his attention to the duality of the brain:—'A boy, in climbing a high tree for a rook's nest, missed his footing, and fell on the sharp edge of an iron railway, one of the earliest laid down in this country, and on a different principle from those now in use, the wheel passing in a sort of groove, instead of on the edge of a projection. The side of the iron rail stood up, and was exposed to the friction of the outer side of the wheel, which soon wore it to a sharp edge. The boy fell head-downwards on this; it entered about an inch from the falx and sliced off a large portion of brain, with nearly the whole of the parietal bone; much of the brain being torn and ragged, I pared off the projecting fragments and replaced the mass, not having the slightest hope of his recovery, and only occupying myself with the task of laying on plasters and bandages to appease the anxiety of the friends. The quantity of the brain lost must have exceeded four ounces, but my recollection of the case is vague after an interval of more than thirty years. Having always read that the integrity of both hemispheres was essential to the due exercise of *mind*, I was much astonished the next day to find the patient (a remarkably intelligent lad, of twelve or thirteen years of age) in the full possession of his faculties in as high a degree as at any former period. He did not seem to suffer pain,—had no delirium,—and advanced steadily towards recovery; considerable new growth took place; but of its nature I have no recollection; it was probably fungous; at the end of a few weeks he was so well that, in spite of the remonstrances of his mother, he went into the field to play; became exceedingly heated by this, under exposure to a violent sun, and then walked deliberately into the water to cool himself. The new blood-vessels burst, and he died of hæmorrhage; never having manifested from first to last any loss or perversion of mental power."

It seems impossible to doubt that in this case the part of the brain which was destroyed was large enough and important enough to have seriously affected the mental power had the brain been a single organ. Nay, it would seem probable that just as one eye would be rendered for a while entirely useless by some serious injury, so the whole half of the brain, on the side which had suffered injury, must for a time have been useless. Therefore as the boy showed no loss of mental power, the other half must have been a perfect brain in itself.

Let us consider, however, some cases which seem still more decisive.

(To be continued.)

* Wigan makes the following remarks on the Falx and the Tentorium:—The object of these membranes, which are as tightly stretched as the skin of a drum, seems to be to prevent the mischievous consequences of the concussion of the brain in sudden movements; as jumping, for example—the elastic membrane gives way to the impulse, and thus diminishes the shock. The falx is also of great utility in preventing the pressure of one brain on the other in lying down; and the transverse membrane, called the tentorium, performs a similar office; it forms a kind of tent (whence its name), and covers a deep hollow in the back of the skull, which contains the cerebellum, and thus preserves it from the pressure of the superincumbent mass of cerebrum.

DREAMS:

THEIR PLACE IN THE GROWTH OF PRIMITIVE BELIEFS.

By Edward Clodd.

VIII.

IN proof of the closing remarks in the previous paper, that the breath has given the chief name to the soul, we find the Western Australians using the same word, *waug*, for "breath, spirit, soul;" in Java the word *nawa* is used for "health, life, soul;" in the Dakotah tongue *niya* is literally "breath," figuratively "life;" in Netela *piuts* is "breath" and "soul;" in Eskimo *silla* means air and wind, and is also the word that conveys the highest idea of the world as a whole, and of the reasoning faculty. The supreme existence they call *Sillam Innua*, Owner of the Air, or of the All; in the Yakama tongue of Oregon *wkrisha* signifies there is wind, *wkrishwit*, life; with the Aztecs *ehecatl* expressed both air, life, and the soul, and, personified in their myths, it was said to have been born of the breath of Tezcatlipoca, their highest divinity, who himself is often called Yoalliehecatl, the Wind of Night.* This identity of wind with breath, of breath with spirit, and thence of spirit with the Great Spirit, which

> Sees him in cloud, and hears him in the wind,

has further illustration in the legends of the Quiches, in which the unknown creative power is Hurakan, a name familiar to us under the form *hurricane*, and in our own sacred records where the advent of the Holy Spirit is described "as of a rushing, mighty wind."† In the Mohawk language *atonritz*, the "soul," is from *atonrion*, "to breathe"; whilst, as showing the analogy between the effects of restricted sense and restricted civilisation, Dr. Tylor quotes the case of a girl who was a deaf-mute as well as blind, and who, when telling a dream in gesture-language, said:

* Brinton's "Myths of the New World," p. 51. (Second Edition.)
† Cf. Knowledge, June 1, 1883, p. 321.

"I thought God took away my breath to heaven." Among the higher languages the same evidence abides.

"The spirit doth but mean the breath."

That word *spirit* is derived from a verb *spirare*, which means "to draw breath;" *Animus*, "the mind," is cognate with *anima*, "air;" in Irish, which belongs to the same family of speech as Latin, namely, the Aryan or Indo-European, we have *anal*, "breath," and *anam*, "life," or "soul;" and in Sanskrit, which is the oldest member of that family, or has, at least, best preserved the primitive forms, we find the root *an*, to "blow" or "breathe," whence *anila*, "wind," and in Greek *anemos*, with the like meaning. The Greek *psyche*, *pneuma*, and *thymos*, each meaning "soul" and "spirit," are from roots expressing the wind or breath. In Slavonic the root *du* has developed the meaning of breath into that of soul or spirit, and the dialect of the gipsies have *duk* with the meanings of breath, spirit, ghost. That word *ghost*, the German *geist*, the Dutch *geest*, from a root meaning to blow with violence, is connected with *gust*, *gas*, *geyser*, in Scandinavian, *glösor*, "to pour forth." In non-Aryan languages, as the Finnish, *far* means "soul, breath, spirit, wind"; *henki*, "spirit, person, breath, air"; the Hebrew *nephesh*, "breath," has also the meanings of "life, soul, mind," and *ruach* and *neshamah*, to which the Arabic *nefs* and *ruh* correspond, pass from meaning "breath" to "spirit." The legend of man's creation records that he became a living soul through the breathing of God into his nostrils "the breath of life," and concerning this the Psalmist says of all that live, "Thou takest away their breath, they die, and return unto the dust. As a final illustration, the Egyptian *kneph* has the alternative meanings of "life" and "breath."*

When we pass from names to descriptions, we find the same underlying idea of the ethereal nature of spirit. The natives of Nicaragua, California, and other countries remote from these, agree in describing the other self as air or breeze, which passes in and out through the mouth and nostrils. The Tongans conceived it as the aëriform part of the body, related to it as the perfume to the flower. The Greenlanders describe it as pale and soft, as without flesh and bone, so that he who tries to seize it grasps nothing. The Congo negroes leave the house of the dead unswept for a year, lest the dust should injure the delicate substance of the ghost; and the German peasants have a saying that a door should not be slammed, lest a soul gets pinched in it. In some parts of Northern Europe, when the wind-god, Odin, rides the sky with his furious spectral host, the peasants open the windows of every sick-room that the soul of the dying may have free exit to join the wild chase; whilst both here and in France it is still no uncommon practice to open doors and windows that the soul may depart quickly. Dr. Tylor† cites a passage from Hampole's "Ayenbite of Inwyt," *i.e.*, "Remorse of Conscience," a poem of the fourteenth century, in which the author speaks of the intenser suffering which the soul undergoes in purgatory by reason of its delicate organisation.

> The soul is more tendre and nesche (soft)
> Than the bodi that hath bones and fleysche;
> Thanne the soul that is so tendere of kinde,
> Mote nedis hure penaunce hardere-y-finde,
> Than eni bodi that evere on live was,

* Jacob Grimm remarks that whilst the more palpable breath, as spirit, is masculine, the living, life-giving soul is treated as a delicate feminine essence. *Soul* is the Icelandic *sála*, German *seele*, Gothic *saiwala*, akin to *saivs*, which means "the sea." *Saivs* is from a root, *si*, or *siv*, the Greek *seio*, to shake, and this choice of the word *saivala* may indicate that the ancient Teutons conceived of the soul "as a sea within, heaving up and down with every breath, and reflecting heaven and earth on the mirror of the deep."

† "Prim. Culture," I., 412.

a doctrine clearly due to Patristic theories of incorporeal souls. And a modern poet, Dante Rossetti, in his "Blessed Damozel," when he describes her as leaning out from the gold bar of heaven and looking down towards the earth, spinning like a fretful midge, whence she awaits the coming of her lover, depicts the souls mounting up to God as passing by her "like thin flames." The Greeks and, following them, the Romans, conceived the soul as of thin, impalpable texture, as exhaled with the dying breath, or, as in Homer, rushing out through the wound that causes the warrior's death. In the metaphysical Arabian romance of Yokdhan, the hero seeks the source of life and thought, and discovers in one of the cavities of the heart a bluish vapour, which was the living soul. Among the Hebrews it was of shadowy nature, with echoless motion, haunting a ghostly realm:

> It is a land of shadows; yea, the land
> Itself is but a shadow, and the race
> That dwell therein are voices, forms of forms.

Such conceptions are but little varied; and, to this day, the intelligence of the major number of people who think about the thing at all presents the departing soul as something vaporous, as a little white cloud.

In keeping with such ideas, the belief in transfer of spirit expresses itself. Algonkin women who desired to become mothers flocked to the couch of those about to die, in hope that the vital principle as it passed from the body would enter theirs. Among the Seminoles of Florida, when a woman died in childbirth, the infant was held over her face to receive her parting spirit, and thus acquire strength and knowledge for its future use. So among the Tákahlis, the priest is accustomed to lay his hand on the head of the nearest relative of the deceased, and to blow into him the soul of the departed, which is supposed to come to life in his next child.*

In Harland and Wilkinson's "Lancashire Folk-lore," it is related that while a well-known witch lay dying, "she must needs, before she could 'shuffle off this mortal coil,' transfer her *familiar spirit* to some trusty successor. An intimate acquaintance from a neighbouring township was consequently sent for in all haste, and on her arrival was immediately closeted with her dying friend. What passed between them has never fully transpired, but it is asserted that at the close of the interview this associate *received the witch's last breath into her mouth, and with it her familiar spirit.* The powers for good or evil of the dreaded woman were thus transferred to her companion, and on passing along the road from Burnley to Blackburn we can point out a farmhouse at no great distance, with whose thrifty matron no neighbouring farmer will yet dare to quarrel." When a Roman lay at the point of death, his nearest relative inhaled the last breath; in New Testament story, the risen Jesus breathes on his disciples, that they may receive the Holy Spirit, and the form thus adopted in conferring supernatural grace is still used in the rites and ceremonies of the Catholic Church.

Speculation about the other self could not, however, stop at identifying it with a man's breath or shadow, or with regarding it as absolutely impalpable. These nebulous and gaseous theories necessarily condensed, as it were, into theories of semi-substantiality still charged with ethereal conceptions, but giving embodiment to the soul to account for the appearances of both dead and living in dreams, when their persons were clasped, their forms and features seen, and their voices heard.

Such theories involve a kind of continuity of identity, and often take the form of belief in the soul as a replica

* Brinton, p. 271.

of the body, and as suffering corresponding mutilation. When the native Australian has slain his foe, he cuts off his right thumb, so as to prevent him from throwing a shadowy spear; the Chinese dread of decapitation, lest their spirits are headless, is well known; but a more telling illustration is that cited by Dr. Tylor, from Waitz, of the West Indian planter, whose slaves sought refuge from the lash and toil in suicide. But he was too cunning for them; he cut off the heads and hands of the corpses, that the survivors might see that not even death could save them from a taskmaster who could maim their souls in the next world. Among advanced nations the same conceptions survived. Achilles, resting by the shore, sees the dead Patroclus in a dream. "Ay me, there remaineth then, even in the home of Hades, a spirit and phantom of the dead, for all night long hath the ghost of hapless Patroclus stood over me, wailing and making moan."* Virgil portrays Æneas, and Homer describes Ulysses, as recognising their old comrades when they enter the "viewless shades," where the dwellers continue the tasks of their earthly life. In Hebrew legend Saul recognises the shade of Samuel when the magic spells of the Witch of Endor evokes it, although the grave of the old "judge" was sixty miles away. The monarch-shades of "Sheol" hail with derision the entrance of the King of Babylon among them. In New Testament narrative the risen Jesus is alternately material and spiritual, now passing through closed doors, and now submitting his wound-prints to the touch of the doubter. In "Hamlet" the ghost is as "the air, invulnerable," yet "like a king" . . .

> . . . that fair and warlike form
> In which the majesty of buried Denmark
> Did sometimes march.

Notions of material punishments and rewards involved notions of a material soul, even pending its reunion with the body at the general resurrection. The angels are depicted as weighing souls in a literal balance, while devils clinging to the scales endeavoured to disturb the equilibrium. In some frescoes of the fourteenth century, on the walls of the Campo Santo, at Pisa, illustrations of these notions abound; the soul is portrayed as a sexless child rising out of the mouth of the corpse, and eagerly awaited as the crown of rejoicing of the angels, or as the lawful prey of the demons. After this it is amusing to learn that extreme tests of the weight of ghosts are now and then forthcoming,† from the assertion of a Basuto divine that the late queen had been bestriding his shoulders, and he never felt such a weight in his life, to the alleged modern spiritualistic reckoning of the weight of a human soul at from three to four ounces! And do not spirit-photographs adorn the albums of the credulous?

THE WESTINGHOUSE BRAKE.

By Trevithick.

(*Continued from page* 160.)

I HAVE already indicated several of the features of the Westinghouse brake, but it remains to detail them specifically in order to show the superiority inherent to the apparatus when compared with other systems.

In the first place, rapidity of action is one great essential in order that a train may be stopped instantaneously. Not only must the effect be felt upon the engine, but throughout the entire train, and that simultaneously. I was considerably impressed by the working of a model which I saw at the works of the company, resembling in every feature a train of sixteen carriages. The moment the air was released from the main pipe the brake cylinders operated, and within $1\frac{1}{2}$ seconds the pistons had reached the limit of their stroke, the whole of them moving together. In actual working the brakes are therefore fully on in $1\frac{1}{2}$ seconds. This results from there being only a small volume of air to release, and that at a high pressure. In the case of a vacuum brake, where there is only a part of the pressure of the atmosphere (10 lb.) to work with, as compared with 70 lb. on the Westinghouse pressure brake, a much larger pipe is necessary in order to apply the brakes with sufficient force to be effective. A large pipe implies of necessity the movement of a larger volume of air. Whereas the Westinghouse is fully applied to a train of fifteen vehicles by the withdrawal of 900 cubic inches of air, at least 27,000 cubic inches have to be moved through the large vacuum-pipe to accomplish a like result. Further than this, the use of auxiliary reservoirs assists in producing an instantaneous application, for without them the rear carriages could only be affected several seconds (fifteen and more) after those in front. The use of the triple valve, which controls the brake cylinder, is, therefore, apparent, and it is most certainly a simple, as well as a highly useful factor, notwithstanding what Sir E. Watkin and other apparently ignorant opponents of the only efficient brake, may say to the contrary.

Another important feature is that the brake is capable of being operated from the guard's van as well as from the engine, and is also capable of being so fitted as to place it under the control of every passenger in the train. The advantage of this is too evident to warrant any enlargement upon it. It will be borne in mind that it operates automatically upon each section of the train, should any of the couplings be accidentally broken.

The fact of a reduction of pressure causing the application of the brake is also an excellent "tell-tale," and ensures the proper maintenance of the whole apparatus. A driver is consequently able to place implicit confidence in the brake, and has no fear of its being unable to operate whenever he may require it. The advantage of this is seen in the ease with which the Great Eastern local traffic, which is reputed to be the heaviest of its kind in the world, is conducted. Where this confidence is not placed, or, worse still, where it is misplaced, delay, if not disaster, is a frequent result. It is no unusual occurrence for the driver of a train fitted with a Clayton brake (which is constructed so as to release the wheels within one and a half minutes), after pulling-up outside a station, to find that he is without the necessary vacuum to apply the brakes at the platform, so that his train goes too far. If this happens at a terminal station, the engine may be impelled violently against the buffer-stops, doing thereby a greater or less amount of damage.

There are, of course, several minor details with which I have not thought it desirable to deal in these articles, the object in view being simply to give an outline of the general arrangement in as popular a form as possible. What I have said in praise of the Westinghouse brake is only a portion of what might be said. The Board of Trade has laid down certain very practical and wise conditions which it urges the various companies to comply with in the matter of brakes; but it seems that there is only one brake which satisfies all these conditions, and this brake has wisely been adopted by the following companies, viz.: the North-Eastern, the London and Brighton, the Great Eastern, the Chatham and Dover, the North British, the Caledonian, the Glasgow and South-Western, the Great North of Scotland, the Rhymney, the West Lancashire, and Eastern

* "Iliad," xxiii., 103. † "Prim. Culture," I., 411.

and Midlands Railway. (It is worthy of note that the vehicles jointly owned by the English and Scotch companies working the three great routes to Scotland—viz., the East Coast, the West Coast, and the Midland Scotch Joint Stocks—are fitted with the Westinghouse automatic brake.) Most of the companies mentioned use the brake very extensively, and the testimony of Mr. T. E. Harrison (engineer-in-chief to the North-Eastern Railway) in his report, previously alluded to, is worth quoting. "There does not appear," he says, "to be any one point in the principle and arrangement of the Westinghouse brake, as now in use, requiring alteration, and it entirely complies with all the requirements of the Board of Trade."

I may add that during three years and nine months there has been an increase in the sales of Westinghouse automatic brakes of 8,276 sets of apparatus for engines, and 49,563 for carriages and waggons, there being altogether on the 30th of April last, 11,553 sets for engines, and 63,065 for carriages and waggons.

It only remains for the public to express a forcible and determined opinion on the subject for the whole of the Companies to adopt this brake. It is better for the public to bring about the desired change, than to resort to Parliamentary coercion; more especially is this the case when it happens that there is only one firm able to do what is required. There are, of course, accidents in which any brake would be useless, such, for example, as the Forth Bridge and the Abergele disasters. The former is too fresh in the minds of the public to need more extensive reference; the latter resulted from some runaway trucks loaded with casks of petroleum making their way down an incline, and meeting with the Irish mail, which was travelling in the opposite direction at full speed. The collision was inevitable, the casks were burst, the petroleum caught fire, and the flames and smoke enveloped the front portion of the train, stifling or burning every person within the carriages.

MORE ABOUT SUNFLOWERS.

By Grant Allen.

In order to answer Mr. Paulson's very interesting and suggestive queries about the sunflower, I think I shall have to write another short article upon the same subject.

The tiny drops of viscid liquid upon the ends of the protective bracts which cover the unopened florets while still in their bud condition consist of a resinous material, which can be collected on the finger in sufficient quantities both to show its thickness and to allow one to experiment upon its gustatory qualities. Its taste is decidedly nasty, and I have very little doubt it acts as a deterrent to destructive insects, which might otherwise burrow their way among the unopened flowers for the sake of the immature pollen, as we know occurs in many other kinds of composites. On cutting open several heads of sunflowers I find many small insects (chiefly beetles and weevils) wandering about among the florets in the male, female, and over-blown condition, but not one among the central unopened buds. I am strongly inclined to suppose, therefore, that the latter owe their immunity from premature rifling in great part to the disagreeable sticky secretion. But I observe also that bees avoid the central disk, which seems such a convenient landing-stage, and concentrate themselves upon the two rings of male and female flowers; and this is obviously beneficial to the plant, since, if they landed first on the centre of the disk, they would carry pollen from the inner male florets to the outer females ones of the same breed, thus defeating the great object of the highest sort of cross-fertilisation—impregnation of the stigma by pollen brought from a totally distinct plant. The resinous secretion may therefore serve a double purpose, first, in protecting the young buds, and, secondly, in compelling bees to alight and visit the flowers in the order most conducive to cross-fertilisation.

The mechanism for the withdrawal of the anthers and style after their functions have been respectively performed is so minutely curious that I feared to describe it in full, lest it should prove tedious to the readers of Knowledge. Since I am asked for it, however, here it is, as well as I am able to explain it.

The style, with its two sensitive stigmatic surfaces folded closely together, is enclosed in the united anther tube, and has numerous small hairs, pointing upwards, on its outer surface. The pollen-sacs open inward, and fill the hollow cylinder thus formed with shed pollen, before the separate florets open. As each floret matures for its first (male) stage, the style pushes upward, inside the anther-tube, and the hairs on its surface drive the pollen to the top of the tube, where it stands in a little heap, as soon as the flower opens. The filaments are sensitive (a fact which can be tested in a manner I will presently describe), and as soon as the proboscis of an insect touches them they contract, thus slightly withdrawing the anther tube, and shedding the pollen over him at the exact right moment to ensure its being employed in fertilising another flower. After the pollen has thus all been shed, the filaments continue still further to contract, apparently by mere fading, till the style protrudes from the top of the anther-sac. The filaments, however, are still so elastic that one can pull them out with the finger almost to the original length. The depression of the anthers into the tube of the corolla seems to be aided in part by the unfolding of the style, which now curves over its two branches, thus displaying the receptive stigmatic papillæ, which catch the pollen and induce it to emit pollen-tubes. If the floret is fertilised by a bee, well and good; if not, the branches of the style bend over until they come in contact with the pollen swept by the hairs of a neighbouring style from a sister floret. They thus secure the second-best sort of cross-fertilisation, that from another flower of the same head. As soon as fertilisation has taken place, the curved branches wither, the style shrinks or shrivels just as the filaments had done before, and the entire mechanism is finally withdrawn within the tube of the corolla. At the same time, the corolla as a whole bends outward at the base, becomes hump-backed as it were, so as to turn away from the centre and thus avoid distracting the attention of the insect visitors. The lobes also bend together slightly, as if to deter the bee from trying these already over-blown flowers. The shrinkage in each case seems to me to be merely due to the usual shrivelling of all parts which have fulfilled their function, but in the filaments it is greatest on the inner surface, so as to make them bow outward. As long as the style and the filaments are still actively required, they are full of juice and vigour; as soon as the pollen is shed and the ovary fertilised, they become at once flaccid and contracted.

In order to observe the sensitiveness of the filaments, take a fully-open sunflower, and select a few florets (without removing them from the head) in the highest perfection of the male stage, when the pollen stands in a little heap at the top of the anther tube. Then, with a needle, or, still better, a soft bristle, remove the pollen gently from the summit of the anthers. You will thus be enabled to observe better the after effect. Next, push the needle or bristle down the corolla tube, and gently irritate the base of the filaments, exactly as an insect would do with its proboscis in searching for honey. You will observe in a

XUM

moment that more pollen is beginning to exude from the top of the anther tube, its exudation being due to the contraction of the sensitive filaments, which draw down the anthers, and so cause the pollen to be expelled by the hairs on the surface of the style. After continuing the irritation for twenty seconds or so, again brush off the pollen from the top of the tube. You will find that the anthers have now receded somewhat, and that the style, with its branches still closely pressed together, begins to protrude slightly from the summit of the anthers. In other words, you have given the flower its cue for passing from the first or male to the second or female stage. As soon as that cue is once given, the change proceeds apace—the anthers continue to shrink down into the corolla, and the style to open its branches.

The question of the mechanism for ensuring irritability in the filament, I must leave to better microscopists than myself.

This is rather a more technical paper than usual, and I fear some readers may find it difficult of comprehension. But if they will take a sunflower in its prime, and cut it in two, following the description with the living object, I think it will all become quite clear to them.

THE EARTH'S SHAPE AND MOTIONS.

By Richard A. Proctor.

(*Continued from page* 176.)

CHAPTER IV.—DETERMINING THE SHAPE OF THE EARTH.

As our observer sets out on his northward journey he sees the earth spread forth as a plane before him in that direction as well as in others; and, therefore, his natural conclusion is that he is about to voyage in a straight line. This, at least, is the assumption on which all his observations must, in the first instance, be grounded.

Let us suppose that an observer travels about 380 miles towards the north before recommencing his observations of the skies; although not very important for the particular observations now to be made, we shall yet suppose that he has taken careful count of time, and has with him the means of measuring time throughout his observations.

He proceeds precisely as at his first station; and, after a similar series of observations, he finds results strikingly similar to those before obtained. He finds the whole heavens rotating in appearance about a fixed axis, with perfect uniformity, and at precisely the same rate as he had noticed when at his former station. But one important difference attracts his attention. He finds that the point about which the stars appear to move (which point he may determine either as before by watching the daily motion of the sun in spring or autumn—for we suppose him to settle for some time at his new post—or by watching the motions of the stars themselves) is higher up above the northern horizon. Measuring carefully the extent of the change, he finds that instead of being about 51½° the pole is now about 57° above the horizon.

Let us see what this result seems to teach :—

Let A (Fig. 1) be the first station of the observer, B the second, so that A B represents a distance of about 380 miles. Then if the assumption that the observer has been travelling in a straight line is correct, he must draw A P at an angle of 51½° with A N, and B P at an angle of 57°, these lines of course meeting, and so forming a triangle A P B, whose vertical angle A P B is the difference between 57° and 51½°, that is 5½°.

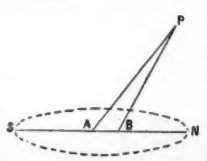


Fig. 1.

Now, before proceeding further, we notice here a source of perplexity.

When at A the observer found the whole of the heavens moving exactly as though they were rotating around the axis A P; and now, when he is at B, he finds them moving exactly as though they were rotating around the axis B P.

It need hardly be said that rotation cannot take place simultaneously around two intersecting axes. Therefore, we must select one of two alternatives. Either we must abandon the notion of a uniform rotation, which seemed in so simple and beautiful a manner to account for observed appearances, or we must give up the theory that in travelling along the earth surface the observer has followed a straight line.

Now about the first of these alternatives, it is easy to form an opinion. We know *certainly* that the line of sight from A to a star traces out the surface of a right cone, having A P as axis. We know with equal certainty that the same is true of the star as seen from B. Hence, in place of the uniform circular motion we deduced before, we require that the star should travel along the complex (and not even plane) curve which is the intersection of two right cones having intersecting axes. But we need not follow out the difficult considerations here suggested; for we can take the case where the cone becomes a plain, and so simplify matters.

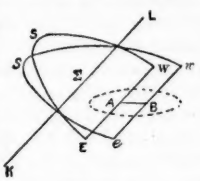


Fig. 2.

Let E S W (Fig. 2) be the path of a star which rises in the east, as seen from A. Then the line of sight from A to this star lies always in the plane E A W S. But the same star, as seen from B, also rises in the east and sets in the west, attaining a lower altitude in the south by 5°.

Therefore its apparent path lies as *e s w* in the plane *e* B *w s*. This plane intersects the plane E A W S in a straight line K L, and it is only by moving along the straight line K L, starting with an infinite velocity from an infinite distance in direction K, travelling with a continually diminishing velocity up to Σ, and thence passing away with a continually increasing velocity to infinity towards L, that the star could appear to move as it actually does when viewed from A and B. The journey from infinity in direction Σ K to infinity in direction Σ L would, according to this view, occupy but half a day, and in some inscrutable manner the star would return in the next half day to its original position, at an infinite distance from us, in direction Σ K. This is altogether absurd and incredible.

Our observer, therefore, finds himself compelled to abandon the theory that he has travelled in a straight line from A to B. But, to make assurance doubly sure, he applies other experiments.

It will be seen at once (from Fig. 1), that if A B really were a straight line, the distance of P could be at once determined, either by a geometrical construction or by calculation. Suppose the observer applies either method, and then makes another journey equal in length to A B, and still due northward; then, renewing his observations of the heavens, he would have it in his power to make a new calculation of the distance of P from A; and if his assumption that he was following a straight path were correct, his new estimate of A P should agree with his

former one. But this he does not find to be the case. When he has got to C (Fig. 3), making B C, equal to A B, he finds that the pole of the heavens has risen by exactly as much as it was raised by his former journey. Now, if we draw a line from C to P, we get an angle C P B, which a very brief consideration will show to be larger than the angle A P B—that is, we get P C N larger than our observer actually finds it, so that, as seen from C, the pole has another direction, as C P′ P″, giving the angle C P″ B, equal to the angle A P B.

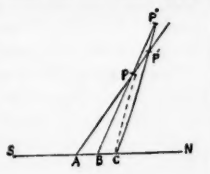


Fig. 3.

But which of the three points P, P′, and P″, is the real pole? They cannot all three be. Yet, if our traveller takes the observations made at A and B, he gets the point P by purely geometrical reasoning; if he takes the observations made at B and C, he gets the point P″ with equal reason; and if he takes the observations made at A and C, he gets the point P′.

He is forced, then, by this second line of argument, also, to abandon the notion that he has been travelling in a straight line.

He has now to consider what his observations require from him. He has first, to get the axis, B P, in Fig. 1, coincident in direction with A P.

He draws A N (Fig. 4) to represent the line on which he set out from A, and he sets up A P at an angle of 51½° to A N. Then he draws at a convenient distance P′ B parallel to A P, and, of course, meeting A N at an angle of 51½°. Now, if he can draw an arc A B, touching A N at A, and having at B a direction (B N′) making an angle of 57° with B P′ then he knows that A B represents very satisfactorily the curved path he must have followed when journeying from A to B. Then again he draws a third parallel, C P″, at the same distance from B P′ that B P′ is from A P; and he makes the arc B C (just as he made the arc A B) so that C N″ may be inclined about 62½° to C P″. This construction makes A B C the arc of a circle, because the circle is the only curve whose tangents (as A N, B N′, C N″) change equally in direction for points separated (as A, B, and C) by equal arcs.

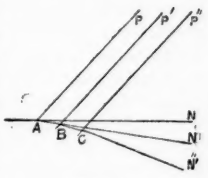


Fig. 4.

The observer is guided, therefore, to the belief that the section of the earth's surface along which he is travelling forms a circle. And he can roughly tell what the size of that circle is. For he has found that A C (Fig. 5) being about 760 miles, the tangent C N″ has fallen away, in direction, about 11° from A N. But if A C L represent the circle of which A C is a part, he knows that lines O A and O C from the centre include the same angle between them as that by which C N″ is inclined to A N.* Hence A C is an arc of about 11°. And therefore the complete circumference of this circle A C L is about $\frac{360}{11}$ × 760 miles, or in round numbers, some 25,000 miles.

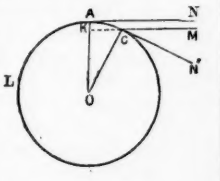


Fig. 5.

* This will perhaps be obvious at once to my readers; but if not, they will easily see its truth by drawing K C M parallel to A N. Then, since O C N″ is a right angle, the angle M C N″ is the complement of K C O. But K O C is also the complement of K C O. Therefore, K O C is equal to M C N″.

This gives to the circle a diameter of about 7,900 miles.

In order, however, to test the justice of this view, our observer first travels farther north. He finds the slow change of elevation of the pole continuing quite uniformly as he continues journeying in that direction. After going as far north as he can, at which time he finds that the pole of the heavens is nearly overhead, he is satisfied that in this direction, at any rate, the circular figure of the path he has followed continues unchanged.

He next returns to A, and commences a series of similar journeys towards the south. These confirm in every respect his theory that the section he is traversing is either actually circular, or does not differ sensibly (so far as his instrumental means are concerned) from the circular form. For every successive distance he travels there appears to be a proportionate depression of the pole. At length the pole sinks to the very horizon, and the relations now presented by the heavens are so interesting that we shall have to consider them attentively.

But first, we must exhibit the general results of our observer's voyages up to this point.

We see from Fig. 6, that even if our traveller's first observations were doubtful on account of the comparative smallness of the changes noticed, yet the great change he now notices—the apparent coincidence of the pole with the horizon—is altogether inexplicable on the assumption that he has been travelling in a straight line. For though undoubtedly by going very far indeed in direction A E he would bring the pole very low down, yet in the first place he would have to travel very much farther than he has actually done, in order that E P might seem horizontal, and in the second, it is absolutely impossible that the heavens should seem to revolve about A P when he was at A, and about a nearly horizontal line E P, when he is at E. On the other hand, we see from Fig. 7, how his uniform progression round the circular arc C B A E would lead to a uniform depression of the polar axis, until at E that axis appeared to lie (as E p) in the horizon-plane of the observer at E.

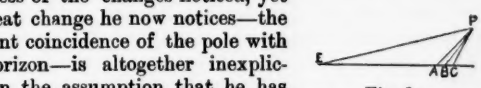


Fig. 6.

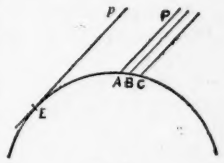


Fig. 7.

And then two things served very strikingly to confirm the views of the traveller. We see from Fig. 6 that on the assumption of the earth being plane, the pole of the heavens P has a distance from points on E C which is comparable with the distances passed over by the observer. This being so, the stars which lay round the axis A P ought not only to change appreciably in brightness as the observer varies his position along E C, but they ought to change in relative position. The polar constellations, for example, could not possibly present the same aspect when viewed from A as when viewed from E. But the observer can detect not the slightest change in the aspect of any one of the constellations he had become familiar with when at A, either in the brightness of the component stars or in their relative position. Now, Fig. 7 accounts perfectly for this. We see all the lines representing the polar axis parallel in position; in other words, the pole is removed to a distance indefinitely great compared with the distances A B, B C, E A, &c. This makes the sphere of the fixed stars very large indeed compared with the arc E C; and while this has been the direct result of geometrical considerations of another sort, it explains at once and simply, the striking fact that, let the traveller journey as he may

along distances which seem enormous when counted by miles, he can yet detect no change whatever in the aspect of the several constellations.

(To be continued.)

AN ADDRESS TO THE BRITISH ASSOCIATION

(GEOGRAPHICAL SECTION), AT MONTREAL, 1884.

By General Sir J. H. Lefroy, R.A., F.R.S., &c.

THE subjoined extracts from General Lefroy's very able address comprise those portions of it possessing the greatest interest for the ordinary reader, as contradistinguished from the professional geographer pure and simple :—

It is scarcely necessary to do more than allude here to the intimate relations between geography and geology. The changes on the earth's surface effected within historical times by the operation of geological causes, and enumerated in geological books, are far more numerous and generally distributed than most persons are aware of; and they are by no means confined to sea-coasts, although the presence of a natural datum in the level of the sea makes them more observed there. A recent German writer, Dr. Hahn, has enumerated ninety-six more or less extensive tracts known to be rising or sinking. We owe to Mr. R. A. Peacock the accumulation of abundant evidence that the island of Jersey had no existence in Ptolemy's time, and probably was not wholly cut off from the continent before the fourth or fifth century. Mr. A. Howarth has collected similar proofs as to the Arctic regions; and every fresh discovery adds to the number. Thus the gallant, ill-fated De Long, a name not to be mentioned without homage to heroic courage and almost superhuman endurance, found evidence that Bennett Island has risen a hundred feet in quite recent times. Nordenskjöld found the remains of whales, evidently killed by the early Dutch fishers on elevated terraces on Martin's Island. The recent conclusion of Professor Hull, that the land between Suez and the Bitter Lakes has risen since the Exodus, throws fresh light on the Mosaic account of that great event; and to go still further south, we learn from the Indian survey that it is "almost certain" that the mean sea-level at Madras is a foot lower, *i.e.*, the land is a foot higher, than it was sixty years ago. If I do not refer to the changes on the west side of Hudson's Bay, for a distance of at least 600 miles, it is only because I presume that the researches of Dr. Robert Bell are too well known here to require it. Any of my hearers who may have visited Bermuda are aware that so greatly has that island subsided, that great hangings of stalactite, unbroken, may be found dipping many feet into the sea, or at all events, into salt-water pools standing at the same level, and we have no reason to suppose the sinking to have come to an end. We learn from the Chinese annals that the so-called Hot Lake Issyk-kul, of Turkestan, was formed by some convulsion of nature about 160 years ago, and there seems no good reason to reject the Japanese legend that Fusiyama itself was suddenly thrown up in the third century before our era (B.C. 286). These are but illustrations of the assertion I began with, that geography and geology are very nearly connected, and it would be equally easy to show on how many points we touch the domain of botany and natural history. The flight of birds has often guided navigators to undiscovered lands. Nordenskjöld went so far as to infer the existence of "vast tracts, with high mountains, with valleys filled with glaciers, and with precipitous peaks" between Wrangel Land and the American shores of the Polar Sea, from no other sign than the multitudes of birds winging their way northward in the spring of 1879, from the *Vega's* winter quarters. The walrus-hunters of Spitzbergen drew the same conclusion in a previous voyage from the flight of birds toward the Pole from the European side. Certainly no traveller in the more northern latitudes of this continent in the autumn can fail to reflect on the ceaseless circulation of the tide of life in the beautiful harmony of nature, when he finds that he can scarcely raise his eyes from his book at any moment, or direct them to any quarter of the heavens, without seeing countless numbers of wild fowl, guided by unerring instinct, directing their timely flight towards the milder climates of the South.

From Central Africa it is not an unnatural transition to Central Asia, the region next the most inaccessible, and pregnant, perhaps, with greater events. The Russian project for diverting the Oxus, or Amu Darya, from the Sea of Aral into the Caspian, remains under investigation. We learn from the lively account of Mr. George Kennan, a recent American traveller, that there is more than one motive for undertaking this great work, if it shall prove practicable. He states that the lowering of the level of the Caspian Sea, in consequence of the great evaporation from its surface, is occasioning the Russian Government great anxiety; that the level is steadily but slowly falling, notwithstanding the enormous quantity of water poured in by the Volga, the Ural, and other rivers. In fact, Colonel Venukof says that the Caspian is drying up fast, and that the fresh-water seals, which form so curious a feature of its fauna, are fast diminishing in number. At first view there would not appear great difficulty in restoring water communication, the point where the river would be diverted being about 216 ft. above the Caspian; but accurate levelling has shown considerable depressions in the intervening tract. As the question is one of great geographical interest, we may devote a few minutes to it. It is not to be doubted that the Oxus, or a branch of it, once flowed into the Caspian Sea. Professor R. Lentz, of the Russian Académie Impériale des Sciences, sums up his investigation of ancient authorities by affirming that there is no satisfactory evidence of its ever having done so before the year 1320; passages which have been quoted from Arab writers of the ninth century only prove, in his opinion, that they did not discriminate between the Caspian Sea and the Sea of Aral. There is evidence that in the thirteenth and fourteenth centuries, the river bifurcated, and one branch found its way to the Caspian, but probably ceased to do so in the sixteenth century. This agrees with Turkoman traditions. Even so late as 1869, the waters of the Oxus reached Lake Sara Kamysh, eighty or ninety miles from their channel, in a great flood, as happened also in 1850, but Sara Kamysh is now some 49 ft. lower than the Caspian, and before they could proceed further an immense basin must be filled. The difficulties then of the restoration by artificial means of a communication which natural causes have cut off, are (*a*) The disappearance of the old bed, which cannot be traced at all over part of the way; (*b*) The possibility that further natural changes, such as have taken place on the Syr-Daria, may defeat the object; (*c*) The immense expenditure under any circumstances necessary, the distance being about 350 miles, which would be out of all proportion to any immediate commercial benefit to be expected. We may very safely conclude that the thing will not be done, nor is it at all probable that

Russian finances will permit the alternative proposal of cutting a purely artificial canal by the shortest line, at an estimated expense of 15 to 20 million roubles.

There are few particulars in which the best atlases of the present day differ more from those published twenty-five years ago than in the information they give us respecting the submerged portions of the globe. The British Islands, with the fifty and one hundred-fathom lines of soundings drawn round them, seem to bear a different relation to each other and to the Continent than they did before. The geography of the bed of the ocean is scarcely less interesting than that of the Continents, or less important to the knowledge of terrestrial physics. Since the celebrated voyage of H.M.S. *Challenger*, no marine researches have been more fruitful of results than those of the *Talisman* and the *Dacia*. The first was employed last year by the French Government to examine the Atlantic coasts from Rochefort to Senegal, and to investigate the hydrography and natural history of the Cape Verde, Canary, and Azores archipelagos. The other ship, with her companion, the *International*, was a private adventure, with the commercial purpose of ascertaining the best line for a submarine telegraph from Spain to the Canaries. These two last made some 550 soundings and discovered three shoals, one of them with less than 50 fathoms of water over it, between the Continent of Africa and the island. If we draw a circle passing through Cape Mogador, Teneriffe, and Funchal, its centre will mark very nearly this submarine elevation; the other two lie to the north of it. The *Talisman* found in mid-ocean but 1,640 fathoms, among soundings previously set down as over 2,000 fathoms. Our knowledge then of the bed of the Atlantic, and of the changes of depth it may be undergoing, is but in its infancy; and we have only to reflect what sort of orographic map of Europe we could hope to draw, by sounding lines dropped a hundred miles apart from the highest clouds, to be conscious of its imperfection. But this knowledge is accumulating, and whether revealing at one moment a profound abyss, or at another an unsuspected summit: marvels of life, form, and colour, or new and pregnant facts of distribution; it promises for a long time to come to furnish inexhaustible interest.

Canada comprises within its limits two spots of a physical interest not surpassed by any others on the globe. I mean the pole of vertical magnetic attraction, commonly called the magnetic pole, and the focus of greatest magnetic force; also often, but incorrectly, called a pole. The first of these, discovered by Ross in 1835, was revisited in May 1847 by officers of the Franklin Expedition, whose observations have perished, and was again reached or very nearly so by McClintock in 1859, and by Schwatka in 1879; neither of these explorers, however, was equipped for observation. The utmost interest attaches to the question whether the magnetic pole has shifted its position in fifty years, and although I am far from rating the difficulty lightly, it is probably approachable overland, without the great cost of an Arctic expedition. The second has never been visited at all, although Dr. R. Bell, in his exploration of Lake Nipigon was within 200 miles of it, and the distance is about the same from the Rat Portage. It is in the neighbourhood of Cat Lake.

One of the finest feats of mountaineering on record was performed last year by Mr. W. W. Graham, who reached an elevation of 23,500 ft. in the Himalayas, about 2,900 ft. above the summit of Chimborazo, whose ascent by Mr. Whymper, in 1880, marked an epoch in these exploits. Mr. Graham was accompanied by an officer of the Swiss army, an experienced mountaineer, and by a professional Swiss guide. They ascended Kabru, a mountain visible from Darjeeling, lying to the west of Kanchinjunga, whose summit still defies the strength of man.

The reported outbreak of a new volcano in the northern part of West Australia, on August 25, 1883, in connection with the great eruption of the Sunda Straits, has not, as far as I know, been verified; but the graphic description of the natives: "Big mountain burn up. He big one sick. Throw him up red stuff, it run down side and burn down grass and trees," seems to leave little doubt of the reality of the occurrence.

THE ELECTRIC LIGHT IN THE MECHERNICH MINES.*

THE electric-light installation at the Mechernich Mines in its once volcanic Eifel district in Rhenish Prussia, has now had a fair trial for more than three years, and has proved a complete success. The expectation that it would both facilitate the operations and increase their security, has fully been realised, and an extension of the plant is now being carried out. Messrs. Siemens and Halske, of Berlin, undertook the work, which was superintended on their behalf by Mr. Boeddinghaus. An open working 2,000 ft. long, 1,000 ft. wide, and over 300 ft. deep, in which 300 men and 20 horses are continually occupied, was first to be supplied with the electric light. This part of the mine is excavated in steps, the horizontal terraces being provided with rails. Ordinary lamps in globes on poles were out of the question, as blasting operations continue throughout the day, and the shots would soon have made havoc of the lamps. After several trials two powerful lamps, of 3,000 candles each, were erected at the upper margin of the pit, where they were fairly out of the reach of the projected stones; and reflectors were fixed to throw the light down upon the steps. To find the proper positions for these powerful lamps and to avoid too dark shadows caused some difficulty. But the illumination was finally rendered most efficient, and the open pit, with the light playing on the whitish grey rock, affords a fine spectacle. As any interruptions, even for short periods, such as those occupied in renewing the lamp carbons, would be dangerous, the whole plant is double, each lamp receiving its current from a D_2 dynamo. No hitch of any kind has occurred, and the safety of the miners has decidedly been augmented. It was formerly not always possible for the superintendents to see whether the loose mass resulting from the blasting operations had been properly removed, and frequent minor accidents arose from the *débris* falling down upon the miners engaged on the step next below. The work can now be controlled much better than before when petroleum lamps and hand lamps were in use. The cost shows a saving of about 4d. per hour in favour of the electric illumination. The satisfactory results obtained in the open working induced the company to introduce the electric light down in the subterranean galleries. The ore forms little concretions of sand and galena scattered all through the rock; the whole mass has therefore to be brought to day to be disintegrated and sifted, and the mining proceeds in parallel and cross galleries, which are constantly being widened until they become 90 ft. in width, and 70 ft. in height, by sometimes 300 ft. in length. The operations in themselves would not require much light if there was not always danger threatening from loosened pieces of rock. Pitch torches were formerly employed to examine the boreholes and fissures round them after each explosion.

* From *Engineering*.

It was a question whether the arc lamps would answer for this purpose in the smoky atmosphere. For the first experiments, arc lamps of 3,000 and 1,000 candles were used, with the positive carbon in the lower holder. The effect was brilliant, yet the light did not penetrate the white smoke cloud which collects at the upper wall immediately after the shot. But as the smoke settles within ten minutes, it was thought advisable to acquiesce in this interruption of a few minutes, and to use smaller lamps of 350 candles, which proved quite efficient. Of these, there are ten in use, with about 10,000 ft. of lead cable, the cable being partially elastic, as the lamps with their wires have to be removed when the blasting is to take place. The lamps were originally supplied with hexagonal lanterns with obscured glass to protect the eyes of the miners. The glasses were, of course, soon broken, but no complaints are said to have been made about the naked electric lights. The proprietors of the mine have decided upon an extension of the installation.

OPTICAL RECREATIONS.

By a Fellow of the Royal Astronomical Society.

(*Continued from page* 130.)

IN all that has preceded, we have, so to speak, taken sight for granted. Before, however, proceeding to examine the phenomena which essentially depend upon the very way in which we see at all—*e.g.*, those of binocular vision and the like—it will be necessary to enter into a little elementary explanation of the structure of the eye itself. The student who may wish to follow this subject out in detail must consult some of the larger textbooks on Human Anatomy. It will conduce to a better appreciation of our description if he will obtain a fresh sheep's or bullock's eye from the butcher.

We shall remark in the outset that the eye-ball is very nearly globular, but the front part (Fig. 25) is more convex than the other portion. Now, excepting this front protuberant part, the eye will be observed to be covered by a

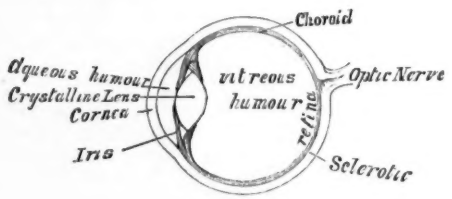


Fig. 25.

thick white membrane called the sclerotic coat, which is popularly known as "the white of the eye." The front of the eye is enclosed by a thick, strong, glassy membrane called the cornea, which suggests the idea of a watch-glass. The light quite obviously passes into the eye through the cornea. From the circle of junction of the cornea and the sclerotic, a kind of opaque coloured plate, with a hole in the middle, separates the front clear part of the eye from the main portion of the interior of the eyeball. It is called the iris, and it is the colour of the iris, which is spoken of as that of the eye, when we talk about blue eyes, grey eyes, brown eyes—and so on. The hole in the centre of this iris is known as the pupil. This appears jet-black, because we look through it at the dark interior of the eye-ball. The function of the pupil is to admit light, and further to regulate the amount of light so admitted. It contracts in the presence of a bright light, and expands in partial darkness—a fact of which the reader may satisfy himself by standing before a looking-glass in a dim light, and watching the pupils of his own eyes when a candle or lamp is suddenly brought near them. The same result may be attained in daylight by shutting the eyes close and opening them suddenly before a mirror. This is all that we can make out from the exterior of the eye. We must dissect it (preferably under water) if we wish to understand its internal structure. Doing so, we shall find that the sclerotic is lined by the choroid membrane, of a dark brown or black colour; as is that again in turn by the retina: the latter being nothing but an expansion of the optic nerve after it enters the eye from the brain. The choroid coat at the front of the eye splits into two layers, one going to form the iris already spoken of, the other taking the shape of a kind of pleated curtain. To this is attached the crystalline lens—an absolutely transparent, double-convex lens, between which and the cornea lies a clear liquid called the aqueous humour, while the greater portion of the cavity of the eye—that behind the crystalline lens—is filled with a transparent, gelatinous substance known as the vitreous humour. Our figure above should make this short description intelligible. From it we gather that the eye consists in effect of an optical instrument, like the camera obscura (Fig. 2, Vol. V., p. 306, and Fig. 20, Vol. VI., p. 46), in which an image formed by the refraction through a combination of lenses of the rays of light emanating from various external objects is projected on to the back of the eye, and being there received on the retina, is conveyed by the optic nerve to the brain. That such an image is formed on the retina, the student may satisfy himself by carefully scraping the back of a bullock's eye (under water) until it becomes thin enough; when, on holding the eye up with the cornea directed to the window, or a well-lighted landscape, a charming little picture of the object towards which it is directed may be seen on the semi-transparent screen to which the hinder part of the eye has been reduced. It will be noted that this image is inverted, and a large amount of unprofitable discussion has arisen as to why we do not see external objects upside-down (as though we had another eye at the back of the first one to view the image formed by that!). The fact is that we do not see anything in the eye, but something wholly external to it. For it is the brain, after all, that sees, and

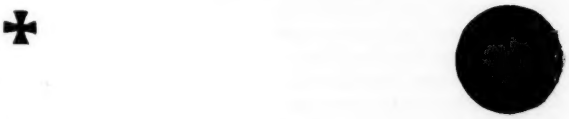


Fig. 26.

not the eye. Sever the optic nerve, and utter and absolute blindness instantly supervenes; albeit the eye, as an optical instrument, remains intact. In the sensorium we refer any object to the direction in which the light from it reaches the eye. If we have to raise the head, as to view the zenith, we say the object regarded is above us or up; if we have to depress the head, as in looking at the ground, we say that the object is beneath us or down. The so-called "mystery" of inverted vision is then, in reality, no mystery at all. Various illustrations may be found of this reference by the brain (through the optic nerve) of external objects to the direction whence the light they emit or reflect enters the eye. For example, press the corner of the eye with the finger, and a patch of light will appear as existing in the direction of the pressure. Look at the bright sky, preferably through an astronomical telescope,

and specks will often be seen floating about, seemingly in the heavens, and travelling slowly downwards. When these assume the appearance of minute transparent spheres, they become a source of annoyance to the observer of small stars in daylight, whose appearance they simulate. They are really extremely minute specks floating in the vitreous humour (Fig. 25). Or the very curious and instructive experiment devised by Purkinje may be tried. It is thus performed: You take a lighted candle into an otherwise totally darkened room; shut the left eye, and hold the candle as close as you can to the right eye (say three inches from it), to the right and rather in front, so as to light up the retina strongly. Keeping the right eye steadily fixed on the opposite wall, you move the candle about into various positions. Now, the glare of the light will soon cause the field to appear dark, and then, as the gentle motion of the candle continues, suddenly there starts into view on the wall a strange ghostly kind of branching net-work, or thing like the upper part of an oak-tree when the leaves are off in winter. This is really an image of the blood-vessels of the retina. They enter the eye at the same point as the optic nerve, and spread out over the sensitive surface of the retina. The candle casts their shadows upon it, and they are projected, and seem to exist on the opposite wall. The words "sensitive surface of the retina," which we have just written, suggest to us to remark that the retina is by no means equally sensitive over its whole area; in fact, that, as we shall immediately see, there is one spot in it which is absolutely blind or insensitive to light, while in another the greatest exaltation of visual perception obtains. In the axis of the eye is situated what is known as the central spot, a thinning or actual depression of the retina. If we look out over an expanse of country without moving the head or eyes, we shall observe certain objects immediately in front of us, sharply and brilliantly defined; but if we attend a little, we shall note that, as we recede from them, either to the right or the left, upwards or downwards, everything becomes gradually less distinct, and with a more imperfect outline, so that at any considerable angular distance from the point of sharpest vision things become blurred and amorphous. In practice, and unconsciously, we shift the eyes, and so successively take in the various details of the landscape, which we fancy we see altogether; albeit, as we have explained, we do nothing of the sort. The central spot, of which we have spoken above, is the seat of the sharpest vision. On the other hand, the place where the optic nerve enters the eye-ball is utterly insensitive to light, and hence is known as the blind spot. Fig. 26 will enable the reader to verify its existence in his own eye for himself. Let him shut the left eye and steadily regard the little cross with his right one, say at a foot or eighteen inches distance. He will see both the cross itself and the dark disc perfectly. Now, let him slowly bring the page nearer to his face, and at a certain point the circular disc will vanish and the paper appear white. At this instant the image of the disc has fallen upon the blind spot of his right eye. As he continues to approximate the paper to his eye, the disc will once again reappear, its image now falling upon another sensitive part of the retina.

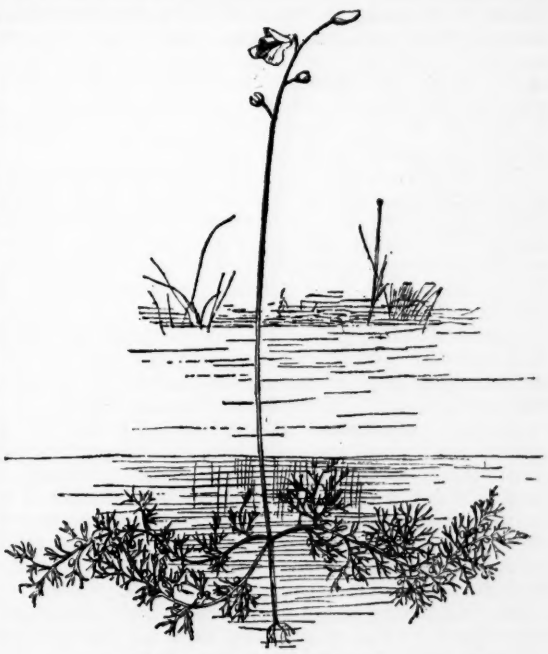
(To be continued.)

Thirty-five years ago the ratio of railway passengers killed in the United Kingdom from causes beyond their own control was one in 4,782,000, while last year it was one in 61,810,000. In 1883 only eleven persons were killed from causes beyond their control. As compared with this, upwards of 200 persons are annually killed in the streets of London.

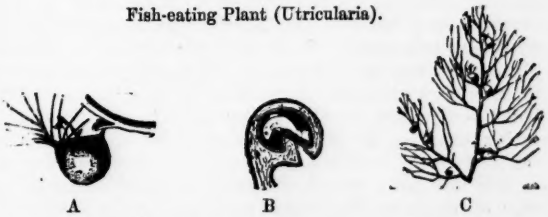
HOW AMERICAN CARP ARE DESTROYED.

There is a little plant, common enough in our ponds, and known as the bladder-wort, which has suddenly sprung into importance for breeders of carp. The bladder-wort (genus *Utricularia*) is a rootless plant fond of still water, and usually found floating half in and half out of water, the branching and stem-like leaves forming the submerged float from which rises the flower stem. To the leaves are attached curiously insect-like bladders filled with water, and varying in size in the different species, reaching at times a diameter of one-fifth of an inch.

It was formerly, and with much probability, supposed that these bladders served the purpose of floats; for until a few years ago it was taken for granted that air and not water filled them. It is now known, however, that the bladders serve a more useful purpose than merely to keep the head of the plant above water; they are the digestive organs of the *Utricularia*, and at the same time are so constructed as to form a very ingenious but extremely simple trap for catching food. It is into these bladders



Fish-eating Plant (Utricularia).



A. Bladder (with small fish caught). B. Longitudinal section of bladder. C. Branch showing leaves and bladder.

that thousands of carp eggs find their unwitting way, together with many insects, crustacea, and other tiny objects, both animate and inanimate.

It is only recently that the *Utricularia* has been accused of destroying carp eggs, but for nearly thirty years it has

been known as a receiver of small insects and crustaceans, and it has been known as an insect feeder for at least twenty years. Mrs. Treat, of America, in 1875 gave a full and interesting description of the habits of one species (*Utricularia clandestina*), and Darwin and others, of Europe, studied the habits of other species in Europe and elsewhere.

In its character as an insectivorous plant the bladder-wort might fail to arouse general interest, but as a destroyer of carp it has a commercial as well as botanical and scientific character. The common bladder-wort (*Utricularia vulgaris*) affords the easiest subject for study, inasmuch as its bladders reach the largest size and may be satisfactorily examined with a moderate magnifier.

The bladder is pear-shaped, with an opening at the small end. Around the mouth are antennæ-like projections or bristles, which, according to Darwin, are for the purpose of warding off and keeping out insects of too great size. The mouth is closed by a valve which yields readily to light pressure, but offers an immovable barrier to the once captured creature. The utmost strength compatible with such a structure has apparently been attained. The valve is a thin and transparent plate, and, by means of the water behind it, is made to stand out a bright spot, which Darwin thinks may attract prey. Something certainly attracts the tiny denizens of the water, for they swim up to the mouth and crawl into the bladder by the readily yielding door. As there is no seductive secretion here, as in the case of many insect-destroying plants, the great naturalist's surmise is probably correct.

Some of the insectivorous plants, on catching their prey, at once pour out a digestive fluid analogous to the gastric juice of the human stomach, but with the *Utricularia* it is not so. The insects or other food when caught in the bladder are merely captives, and swim about in their confined quarters with eager activity in their endeavour to find an outlet, until asphyxia for lack of oxygen comes on. Even now the plant makes no effort to digest the animal food, but waits patiently until decay takes place, and the animal matter is by putrefaction resolved into fluids which the numerous papillæ lining the bladder can absorb.

Darwin's experiments showed not only that living animals could make their way into the bladder, but that inanimate objects falling on the valve would be engulphed with lightning-like rapidity. With all this information to begin with, it is not strange that naturalists should turn to the bladder-wort to seek a solution for the great destruction of the carp, for the carnivorous plant was known to possess facilities not only for the capture of floating spawn, but even of the newly hatched fish. Examination and repeated experiment proved conclusively that the greedy little bladders were making sad havoc with the fish, and in consequence carp breeders are bidden to open war vigorously on *Utricularia* and all its species. It may seem at a hasty glance that the small bladders can hardly be responsible for any very extensive destruction of eggs or small fish, but the doubters of the ability of insignificant agents, acting together, to produce stupendous effects may be referred to the microscopic rhizopods or the earth worms, each in their own way performing wonderful feats in the way of earth building and earth preserving.—*Scientific American.*

Catalpa Ties.—The catalpa is already in use in the south-west of the United States, to some extent, for railway ties. It is a wood of rapid growth, and yet has shown remarkable durability. In an address before an agricultural society in Ohio, General Harrison, of Indiana, mentioned a catalpa foot-log over a small stream in the Wabash county which had been in use for 100 years, and was still sound, showing no sign of decay.

OTHER WORLDS THAN OURS.

A WEEK'S CONVERSATION ON THE PLURALITY OF WORLDS.

By Mons. de Fontenelle.

WITH NOTES BY RICHARD A. PROCTOR.

THE SECOND EVENING (*continued*).

"I FIND," says the Marchioness, "the planets are just like us; we cast that upon others which is in ourselves. The Earth says, 'Tis not I that turn, 'tis the Sun;' the Moon says, 'Tis not I that shake, 'tis the Earth;' the world is full of error."

"But I would not advise you," said I, "to undertake the reforming it; you had better convince yourself of the entire resemblance of the earth and the moon. Imagine, then, these two great bowls suspended in the heavens. You know that the sun always enlightens the one half of a body that is round, and the other half is in the shadow. There is, then, one half of the earth, and one half of the moon, which is enlightened by the sun—that is, one half which is day, and the other half which is night. Observe, also, that as a ball has less force after it has been struck against a wall, and rebounds to the other side, so light is weakened when it is reflected. The pale light which comes to us from the moon is the very light of the sun; but it cannot come to us from the moon but by reflection. It has lost much of the force and lustre it had when it came directly from the sun upon the moon; and that bright light which shines directly upon us from the sun, and which the earth reflects upon the moon, is as pale and weak when it arrives there, so that the light which appears to us in the moon, and which enlightens our nights, is the part of the moon which has day; and that part of the earth which has day, when it is opposite to the part of the moon which has night, gives light to it. All depends upon this, how the moon and the earth behold one another. At the beginning of the month we do not see the moon, because she is between the sun and us; that half of her which has day is then turned toward the sun, and that half which has night is turned towards us; we cannot see it then, because it has no light upon it: but that half of the moon which has night, being turned to the half of the earth which has day, sees us without being perceived; and we then appear to them just as the full moon does to us. So that, as I may say, the people of the moon have then a full earth; but the moon being advanced upon her circle of a month, comes from under the sun, and begins to turn towards us a little corner of the half which is light; which is the crescent: then those parts of the moon which have night, do not see all that half of the earth which has day, and we are then in the wain to them."*

"I comprehend you very well," said the lady; "the people in the moon have a month quite contrary to us; when we have a full moon, their half of the moon which is light, is turned to our half of the earth which is dark; they do not see us at all; and they have then a new earth, this is plain. But now tell me how come the eclipses?"

"You may easily guess that," said I; "when it is new moon she is between the sun and us, and all her dark half is turned towards us who have light, that obscure shadow is cast upon us; if the moon be directly under the sun, that shadow hides him from us, and at the same time obscures a part of that half of the earth which is light; this is seen by that half of the moon which is dark: here

* Fontenelle omits to notice here the varying aspect of the earth to the moon, as rotation turns different parts of her surface moonwards. But he touches on this point in the next chapter.—R. P.

then is an eclipse of the sun to us during our day, and an eclipse of the earth to the moon during her night. When it is full moon the earth is between her and the sun, and all the dark half of the earth is turned towards all the light half of the moon; the shadow then of the earth casts itself towards the moon, and if it falls on the moon, it obscures that light half which we see, which has then day, and hinders the sun from shining on it. Here then is an eclipse of the moon to us during our night,* and an eclipse of the sun to the moon during her day: but the reason that we have not eclipses every time that the moon is between the sun and the earth, or the earth between the sun and the moon, is because these three bodies are not exactly placed in a right line; and by consequence that which should make the eclipse, casts its shadow a little beside that which should be obscured."

"I am surprized," said the Marchioness, "that there should be so little mystery in eclipses, and that the whole world should not know the cause of 'em."

"They never will," said I, "as some people go about it. In the East Indies, when the sun and the moon are in eclipse, they believe a certain devil who has black claws, is seizing on those planets with his talons; and during that time the rivers are covered with the heads of Indians, who are up to the neck in water, because they esteem it a very devout posture, to implore the sun and the moon to defend them against the devil. In America, they are persuaded that the sun and the moon, when eclipsed, are angry, and what is it they will not do to be reconciled with them? The Greeks, who were so refined, did they not believe the moon was enchanted, and that the magicians forced her to descend from heaven, and shed a dangerous juice on the plants? Nay, what a panic were we in, not many years ago, at an eclipse of the sun? How many people hid themselves in their cellars; and all the philosophers could not persuade them to come out 'till the eclipse was over?"

"Methinks," said she, "'tis scandalous for men to be such cowards; there ought to be a general law made to prohibit the discoursing of eclipses, that we might not call to mind the follies that have been said and done upon that subject."

"Your law then," said I, "must abolish even the memory of all things, and forbid us to speak at all, for I know nothing in the world which is not a monument of the folly of man."

(To be continued.)

MUSCULAR CONTRACTION AFTER DEATH.†

DR. BROWN-SÉQUARD maintains that fixed and rigid positions after death, speedily ensuing, are due to the last vital act, which has induced a "tonic contraction," and that causes of death which produce sudden dissolutions without pain or excitement may be the means of such a contraction. Assuming this to be true, still the *modus operandi* by which a vital act can leave such a "tonic contraction" after all vital power has ceased is not suggested by him, and we need one step further in the way of enlightenment. Let us see if we cannot take that step now.

In accordance with the observations of Du Bois Reymond, it has been pretty generally accepted that the normal state of even quiescent living muscle is one of electrical tension, and that during muscular contraction the tension diminishes in such a way that as the wave of contraction moves along the muscle it is preceded by a wave of negative variation. This variation is slight for a single contraction, but in those of great rapidity it may become so great as to completely neutralise the galvanometric deflection due to the normal current of the quiescent muscle.

These views have been attacked and sharply criticised, notably by Hermann in 1867, and as lately as 1877 Engelmann has come to Hermann's aid in Pfluger's "Archiv." They maintain that normal muscle-currents do not exist; and that those observed by Du Bois Reymond were due to the unnatural conditions of the muscles examined by him. He, however, has replied to their criticisms with great ability, and his views are now, as already stated, very generally adopted by physiologists. A consideration of these views may perhaps help us to a clearer idea of the position of the headless soldier of Sedan, as shown in Brown-Séquard's figure.

The conditions required, in order that a limb or the entire body should be in a state of rigidity, are simply that the antagonistic muscles, the flexors and extensors, for instance, should be braced at the same moment to full activity, and the rigidity continues so long as the mutual action remains. If this action is not local, but general, such a figure will continue without motion indefinitely, excepting that gravitation may cause it to fall to the ground, if unsupported. But even such a fall would not affect the limbs: they would necessarily retain their position.

Now Du Bois Reymond has shown us that tonic contraction is the *normal state* of muscle fibre, and that relaxation is due to an accession of vital activity through the agency of nerve force. We know well that commonly when life ceases muscular contractility ceases with it. And we can readily see that when death comes as the result of disease or exhaustion, and is attended with suffering, the perturbation of nerve force and of muscle currents must be so great that such a result will surely follow. And as these include death in almost every form in which we ever witness it, we have naturally come to understand that muscular relaxation is its normal attendant and its immediate result. "He bowed his head" is the fearfully expressive term employed when death came on Calvary.

But in the very few instances where death occurs suddenly and without suffering, it seems possible that the instantaneous cessation of the nerve force may leave every muscle fibre in its *normal condition*. If that could be, universal rigidity would instantaneously ensue, and the last position assumed in life would be retained in death. Now, we know that the one cause of all causes which can bring a death into which the element of time does not enter is a wound which obliterates the base of the brain as well as the commencement of the spinal cord. That there is an interval between the cause and effect is doubtless theoretically true, but practically the interval has no existence, for it is infinitesimal. Such a stroke must necessarily be painless, for life (including of course sensation) is abolished at its occurrence. The two chief cases cited by Brown-Séquard are cases precisely in point.

The cannon-ball at Sedan left nothing remaining above the lower jaw. The brain of the soldier at Goldsborough had been swept by a bullet from a Springfield rifle, that struck him in the right temple, while his head was turned toward his right shoulder, and beyond question inclined downward, for his leg had that instant crossed the saddle, and the stock of his own rifle was still on the ground. Following Du Bois Reymond, it is difficult to see how instantaneous rigidity should not ensue in each of these cases; it did ensue, whether our explanation be correct

* Or rather, during the night of the parts of the earth turned moonwards.—R. P.

† From the *Scientific American*.

XUM

or not. And with each one the state of support was such that he *could not fall* so long as the rigidity continued.

Many questions and conclusions of intense interest are associated herewith, but for the present we must leave them untouched. W. A. O.

THE INTERNATIONAL HEALTH EXHIBITION.

XIV.—WATER AND WATER-SUPPLIES—(*continued*).

IN our remarks upon the "Grant Revolving Ball Water Filter," we drew the attention of our readers to this remarkable contrivance as being one which is peculiarly adapted to the purification of *tolerably* wholesome water, and in doing so provoked a reply from the inventor, who, it is but just to state, has furnished us with ample evidence that the instrument is capable of dealing effectively with even filthy and highly impure waters. We have tested the apparatus, and find the filtrate of our experiments all that could be desired for drinking and for culinary purposes. In cleansing the filter by reversion of the ball, it is somewhat surprising to find, in spite of all theoretical reasoning to the contrary, that the carbon is not *approximately*, but *thoroughly* cleansed, and the operation is so simple that it may be put into action every time that the filter is used, although in reality it does not require such attention more than once or twice daily.

On a large scale, these filters might be fixed with advantage to public drinking-fountains and street-service hydrants, as suggested by the *Home and Colonial Mail*,* when "the policeman on his beat could cleanse them at intervals by merely turning a handle in passing. This handle could be constructed, in filters destined for public hydrants, to allow of its being locked, to prevent damage from mischief."

Type IV.—"The Spongy Iron Filter."—The researches of Prof. Gustav Bischof, which led to the employment of spongy iron as a filtering medium of value, are carefully recorded in the "Proceedings of the Royal Society,"† and one of the most important benefits derived from its use is shown to be due to its destructive action upon organic germs. In his report to the company, Professor Frankland, F.R.S., writes as follows:—‡ "Taking into account the extremely bad quality of the raw material at the time of my visit, I consider this result to be eminently satisfactory from a purely chemical point of view; but there is another factor involved in this result which has still greater weight with me in the comparison of the water before and after treatment, viz., the circumstance that the water has been passed through a material which is absolutely fatal to bacteria and their germs. It has been proved by Prof. Bischof § that water which has passed through spongy iron is entirely free from bacterial germs, and by my pupil, Mr. F. Hatton, working in my laboratory, that spongy iron is the only known substance applicable to the treatment of large volumes of water which immediately destroys living bacteria."‖ We need scarcely add that the immunity from zymotic disease, secured through the use of so valuable an apparatus, ought to be a powerful argument in favour of its general acceptance as a household necessity.

The internal mechanism of the filter may be readily understood by a reference to the figure here annexed (Fig. 27), from which it will be gathered that it is entirely different in plan from any of the appliances which we have hitherto noticed. The following description, which has been kindly furnished to us by the company, will enable the reader to gain an insight into its detailed structure:—"(1) The unfiltered water is supplied by means of ball-cock,

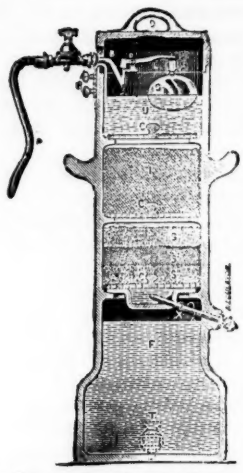


Fig. 27.—Bischof's Spongy Iron Special Ball-cock Filter. B., ball-cock; U., unfiltered water; V., screw-valve; I., spongy iron; S., S′., S″., prepared sand; F., filtered water; T., stop-cock.

B, with glass-ball, G, and screw-valve, V; the latter serves to shut off the water in any emergency. The ball-cock requires no fixing to a wall, but is fastened to the side of the filter-case by screws, R; it is connected with the water-supply or cistern by india-rubber or other tubing, P. The water passes through the several layers of filtering materials, which are enclosed between the perforated plates, C, C′, C″. It is next collected in a small well, or regulator bowl, and thence passes into a tin tube, provided at its outer end with a screw-cap, A. The lateral opening, X, in the side of the tube forms the only communication between the upper part of the filter and the reservoir for filtered water. The flow of water is thus controlled by the size of such opening. (2) The supply of water to this filter should be sufficient to insure the materials remaining covered with water."

Spongy iron is metallic iron in a state of excessively fine division, which renders it sufficiently porous to admit of the percolation of water. It takes the place of the carbon of other filters, and acts virtually in the same way. Apart from its obvious property as a mechanical strainer, it is a chemical purifier. It counteracts lead contamination,* reduces the hardness of water,† and, as we have before noted, is strongly antiseptic as far as organic matters are concerned. Mr. F. Hatton has shown:—‡ (1) "That it acts as a very powerful reducing agent on the carbon compounds composing the organic matter dissolved in water. In some cases marsh gas itself was produced—probably the organic matter was first oxidised to carbonic acid (CO_2), and then the action of the metallic iron on this gas gave rise to marsh gas (CH_4) by the ordinary decomposition of water. (2) The organic nitrogen is in nearly all cases reduced to ammonia."

In its passage, the water dissolves a small quantity of

* July 18, 1884, p. 5.

† "On Putrescent Organic Matter in Potable Water," No. 180, 1877; No. 186, 1878.

‡ Report to the Directors of the "Spongy Iron Water and Sewage Purifying Co.," August 8, 1882.

§ *Op. cit.*, xxvii., p. 258.

‖ "Journ. Chemical Society," xxxix., p. 247.

* "Journal Royal Agricultural Society," vol. xi., part 1, 1875, p. 158.

† "Rivers Pollution Commission," 6th report, p. 220.

‡ "Journal Chemical Society," May, 1881.

the iron, but this is abstracted and retained by the layers of prepared sand underneath. The entire filter is thus composed from below upwards of:—(1) A perforated plate C″, Fig. 27. (2) Fine gravel, S″. (3) Coarse white sand, S′. (4) Black pyrolusite, S. (5) Intermediate perforated plate, C′. (6) Spongy iron, I. (7) An upper perforated plate, C. It thus appears that, as the entire system is constituted by a series of inorganic substances, the liability to decomposition of the filtering medium is entirely dispensed with, and, in consequence, a renewal need not be resorted to more than once in twelve months. The filter may then be taken to pieces, thoroughly cleansed, and recharged, by following the simple directions supplied with each instrument.

Type V.—"The Patent Carbon Paper Water Filter," Fig. 28, manufactured by Messrs. S. H. Johnson & Co., of Stratford, London, E., is constructed upon the principle of combining a theoretically perfect mechanical strainer with a chemical purifier of the highest value. Both of these requirements are premised to be but temporarily obtainable, and bearing this in mind the inventors have sought to produce an instrument which shall fulfil all the duties of a perfect filter with the materials at hand, which can be inexpensively and readily renovated.

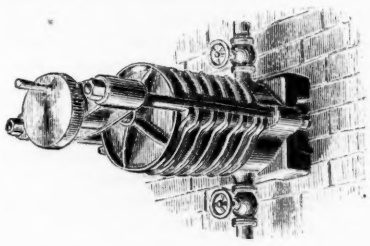


Fig. 28.

Stout filter-paper, into which a quantity of purified animal charcoal (from 10 to 20 per cent. of its weight) has been incorporated, is held within a chambered framework, and operates by means of the pressure in the main-service or household supply pipe. The body of the apparatus consists of a series of apposed compartments, each designed to hold two circular discs of the prepared paper, so that a six-chambered instrument, such as that shown at Fig. 28, would contain twelve of such filtering surfaces.

The unfiltered water passes in at one side, and, after filtration, flows into the supply-pipe under pressure. The substitution of fresh papers is provided for thus:—"The filter can be shut off on both sides from the service-pipe, a small disc run back, and the grooved plates and distance-frames of which the filtering chambers consist can be opened out, and the spent carbon papers changed in the course of a minute or two. When screwed up the machine is again ready for work." The entire arrangement is a novel device, and practically supports the theory upon which it was constructed, and which we have already enunciated.

New Zealand Coal.—The coal trade of the north island of New Zealand promises to be extensive. Coal is found at the Bay of Islands, where a mine is in full operation. At Whangharei two mines are at present working; at Raglan coal of good quality has recently been found, and at the Mokau a seam of excellent coal is seen cropping out to a great thickness for a distance of between twenty and thirty miles. Besides these places, coal is now being worked to a considerable extent at several points on the Waikato, and a large seam of coal—between 50 ft. and 60 ft. in thickness—on the estate of the late Mr. Foote, on the Maramarua Creek, is expected to become a source of supply shortly.

Editorial Gossip.

A less sensational Presidential address than that of Lord Rayleigh to the British Association this year it would be difficult to imagine, and yet it is not without interest for those outside of the comparatively narrow circle of specialists in physics, to whom it primarily appeals. Among the more notable points in it I may refer here to Crookes's masterly discovery of the element Yttrium by the presence of a bright band in the phosphorescent spectra of certain earths, and the proof thence derived of its comparatively wide distribution. The researches, again, of Abney in the ultra-red end of the spectrum, Langley's conclusion (already adverted to in these columns) that the sun would appear of a blue tint if viewed by an eye situated outside of our atmosphere, and the description of Cornu's method of determining whether any given line in the solar spectrum has its origin in the sun or in our own atmosphere must command the attention of all who possess the slightest familiarity with the theory, or practical use, of the spectroscope. Michelsen's final determination, too, of the velocity of light as 186,290 miles per second will be accepted with interest by all concerned in the study of cosmical or astronomical phenomena; while, finally, Lord Rayleigh's brief discussion of the tendency and methods of modern education can scarcely fail to be valuable to a very large number indeed to whom the very British Association itself is but an entity of the vaguest and most shadowy kind.

"There was," says the *Book of Nonsense*—

> "There was an old person of Philæ
> Whose conduct was scroobious and wily"—

conduct which apparently finds very sedulous imitation in certain gentry who try to puff themselves in journals weak enough to fall into the trap they set for them. I may select two illustrations of this of which I have had recent experience. The first is that of a so-called "Spiritualistic" paper which has been moving heaven and earth to provoke me into a discussion, with the sole object of getting a gratuitous advertisement in the columns of Knowledge. Its failure to do so has driven it nearly frantic; but, surely, in vain the net is spread in sight of any bird. The second effort to use this journal comes from a gentleman who has invented something—what, I decline even to hint; but will suppose, for the sake of illustration, that it is an improved hair-pin. Well, the inventor writes to me asking for an appointment that I may see his hair-pin; and goes on to suggest that I should (of course, by puffery) aid him to introduce it into ladies' schools "for our mutual advantage." It affords an instructive notion of the idea which such a person must entertain of the social status, habits, training, and ethics of the editor of a scientific paper, to suppose that he would misuse its pages for the sake of the profit to be got out of selling hair-pins (or anything else) on commission!

I see that the 240th minor planet was discovered on the night of the 28th ult. at Marseilles. It is much to be deplored that the astronomers at the Observatory there had not something more profitable to occupy themselves with.

In addition to the letter printed on p. 206, I have received another from Dr. Kinns, complaining of the paragraph on p. 142, and containing scarcely veiled threats of what he will do if I do not apologise to him. Such threats trouble me but little indeed; but Dr. Kinns—and every one else—is entitled to the most rigid justice; and I

am earnestly anxious that he should have it. When a man voluntarily publishes a book, he, *ipso facto*, subjects that book to the most searching, and, if need be, damaging criticism (always supposing such criticism to be *bonâ fide*, and without malice); nor does the patronage of Lord Shaftesbury, or even of the Lord Mayor himself, exempt him from unfavourable comment. To two expressions in the paragraph in question Dr. Kinns takes especial exception. The first is this: "He claimed to have the sanction and support of, *inter alios*, members of the staff of the British Museum, but this was promptly denied and repudiated by more than one leading member of that staff themselves." The members of the staff who do appear to support Dr. Kinns are Dr. Birch and Mr. Pinches; who are, doubtless, excellent judges of the faithfulness of a translation of a cuneiform inscription, but whose authority as astronomers, physicists, geologists, and palæontologists may reasonably be questioned. As for the repudiation by the *Natural Science* staff of the Museum, see Mr. Carruthers' letter in the *Standard* of Jan. 4, 1884, and the mass of correspondence which appeared in that journal, the *Times*, &c., about, and subsequently to, that period, together with Dr. Kinns's replies. The next expression to which Dr. Kinns objects is "crass ignorance," which he alleges is calculated to do him serious injury. As I would not wilfully injure a human being, and assuredly not a total stranger to me, I withdraw that expression entirely, and invite Dr. Kinns himself to substitute for it, in these columns, his own definition of the mental condition of a man who could believe that refraction, in any form whatever, could cause the sun to appear above the western horizon after the rotation of the earth had carried it—not only beneath the observer's feet—but actually to its point of rising 180° distant! I must, in fairness, add that, at the time of my penning these lines the new edition of Dr. Kinns' book has not reached me. Should it do so before going to press, and I find that the astounding statement to which I have just referred has been expunged from it, I will take care to give the fact all the publicity in my power. Dr. Kinns seems to be labouring under the curious hallucination that his private character and personal honour have been attacked. No such utterly baseless charges were ever brought (or would for a single instant have been suffered to have been brought) against him in these columns. It was his judgment as an author, and that alone, which was assailed, in conjunction with the policy of the action of his committee.

Reviews.

Celestial Motions: a handy book of Astronomy. By W. T. Lynn, B.A., F.R.A.S. Second Edition. (London: Edward Stanford, 1884.)—Scarcely two months have elapsed since our first notice of Mr. Lynn's capital little book, and already the first edition is exhausted. In the second, the two or three printer's errors, &c., which we noticed in p. 483 of our last volume have disappeared, all numerical and other detail is brought down to the very latest date, and a diagram of the orbit of the November meteors has been added. Mr. Lynn's tiny volume has honestly earned the success it has met with.

London Water: A Review of the Present Condition and Suggested Improvements of the Metropolitan Water Supply. By A. de C. Scott, Major-General late R.E. (London: Chapman & Hall. 1884.)—When we read on the first line of General Scott's work that, even in 1882, in addition to the supply from private wells, London consumed daily 146,130,000 gallons of water! the vast importance of the subject which he undertakes to discuss is irresistibly forced upon us. He gives us a succinct history of the Metropolitan Water Supply; and shows very plainly in what respects it breaks down; discusses the various schemes proposed for furnishing a supply of pure water—such as Mr. Bateman's for bringing it from South Wales, Messrs. Hemans and Hassard's, for deriving it from the Lake District; Mr. Fulton's, for obtaining it from the Wye, &c., as well as the idea of Messrs. Homersham and Barlow for sinking very deep wells within the area of the metropolis itself. He appears to be pretty definitely of opinion that the monopoly of the Water Companies has been abused, and that the sooner it is destroyed the better. General Scott's book deserves the attention of every water-consumer in London.

Railway Accidents. By Clement E. Stretton. Third Edition. (London: Simpkin, Marshall, & Co.)—This is a carefully-written pamphlet on the cause and prevention of those calamities which occasionally befal us to remind us of the reality of the danger we more or less wilfully place ourselves in day by day. It is notorious that companies have frequently tried to shield themselves behind their servants, and would sometimes have succeeded had it not been for the timely interposition of Mr. Stretton, who, having devoted time and money to the protection of the servant, is acknowledged as their friend. We commend the little pamphlet to the serious consideration of our readers.

The Electrician's Pocket-Book. By E. Hospitalier. Translated, with additions, by Gordon Wigan, M.A. (London: Cassell & Company, Limited, 1884.)—This is second year's edition of a work which is intended to be issued periodically. It is a very useful volume, teeming with valuable information condensed into a small compass. It has the advantage of being very clearly printed, one great feature being the unusual prominence given to the headings of paragraphs. Reference is in consequence made much simpler than it otherwise would be.

Photography for Amateurs. By T. C. Hepworth; (London: Cassell & Co., 1884.)—Mr. Hepworth has done his work honestly and well, and with the exception of that short chapter on the history of photography with which the author of nearly every manual on the subject seems to consider it incumbent on him to begin his book, there is little that is not instructive to the worker, and which may not be read with profit by the amateur.

How to be a successful Amateur Photographer. By W. J. Lancaster, F.C.S. (Birmingham: J. Lancaster & Son.)—Yet another work on Photography! This time by a member of a well-known firm of manufacturing opticians, who tells us nothing about Victor Niepce, Daguerre, nor Fox Talbot, but who plunges at once *in medias res*, and is most eminently practical from beginning to end. He confines his descriptions of apparatus to those forms constructed by the firm to which he belongs; but, as the reader will soon find out for himself, there is no real disadvantage in this. The exceeding cheapness of Mr. Lancaster's pamphlet places it within everybody's reach, and, moreover, enables the intending photographer to sit down and count the cost of his preliminary essay in the art; a consideration by no means to be lost sight of by the beginner of limited means.

Hygienic Bread is a description of the new hygienic bakery of Messrs. W. Hill & Son.

We have also before us *The Practical Confectioner*, *The Journal of Botany*, and *Amateur Gardening*.

Miscellanea.

Mineral wool is, says the *Scientific American*, used for a packing to deaden the sound between floors in buildings, and being incombustible it is now pretty generally used between the floors and ceilings in new houses. Mineral wool is obtained from the slag from blast furnaces, and is produced by throwing a jet of steam against the stream of slag as it flows from the furnace.

The Blenheim Pictures.—"Atlas," in the *World*, gives some particulars in regard to the sale of the Duke of Marlborough's pictures. The agent in the matter is Mr. Davis, of 147, New Bond-street, London. So far he has been most successful in his sales. For four pictures Mr. Davis has obtained for the Duke £140,000, one of the number being the famous Raphael, for which the Government has undertaken to pay £70,000.

Wide Reach of a Tidal Wave.—A correspondent in the Fiji Islands writes that a notable tidal wave reached there on October 6 last, the date of the great tidal wave, 25 feet high, and the eruption of Mount St. Augustin, in Alaska. The tidal wave in Alaska occurred at 8.25 a.m., and that at the Fiji Islands, about 4,500 miles to the south-west, at 11.45 a.m. At the latter place there were three successive waves, with intervals of ten minutes, which, at the ordinary period of low water, reached nearly to the high-water mark. The occurrence of this disturbance of the sea a few hours later on the same day as the eruption of Mount St. Augustin, and the formation of a new island in its vicinity, suggest that the tidal wave at both places proceeded from the same cause.

In the Interests of Science.—A contemporary is informed that the *Warsaw Courier* has published a letter from a subscriber in which the writer offers himself as a subject to be experimented upon in reference to cholera. "I am unmarried," says he, "I have no ties of any kind, and no plans for the future. I therefore wish to be of use to humanity by undergoing any experiments which have not yet been tried upon human beings. I seek no reward, but should require to be paid my travelling expenses to wherever I might have to go to be experimented upon, and those of my return journey to Warsaw should I be spared to perform it. I may add that I am twenty-four years of age and in good health." The writer says that communications in answer to this may be sent to "Z. A. K.," care of K. Tsibulski, china and glass dealer, Theatre-place, Warsaw.

Coral-Fishing.—Coral-fishing is largely followed in Algeria, 40,000 to 45,000 pounds of coral, valued at about £38,000, being the yearly production; La Calle is the centre of this industry, and there are employed annually 100 boats and 1,300 men. The coral is obtained by means of a wooden apparatus in the shape of a cross, having in its centre a leaden slug or stone for ballast. Nets, the meshes of which are loose, are hung on the bars of the cross and dragged at the bottom of the sea, among the nooks and crevices of the rocks. These nets, winding about the coraline plant, break up or tear off its branches, which adhere to the meshes. The apparatus is drawn up by the fisherman whenever he thinks it sufficiently laden. There is also a net which is provided with large iron nails, having thus greater force to break the coral, but this apparatus is forbidden to be used.—*Scientific American*.

The Abyssinian tube-well for the entire supply of the town of Hertford has been completed by the contractors, Messrs. Le Grand & Sutcliffe, with most satisfactory results. The size of the tube well is 7¼ in., and at 81 ft. the chalk springs are so abundant that the yield is over 100 gallons per minute, or about 150,000 gallons per day. The pumping, when necessary, can be continued night and day with a very small amount of attention, as the motor is a powerful water-wheel worked by the river Lea. This well affords a further illustration of the fact stated by Mr. Robert Sutcliffe at the recent Water Supply Conference held at the Health Exhibition, that it frequently happens there is abundance of good water to be found on the banks of a river that is no longer itself fit to supply water for dietetic purposes. The total saving of the expense of filtration is also a very important item, which might, to some extent, recompense the London water companies for the expense of obtaining their supplies from sources that need no outlay on this head. The total cost of the tube-well, including cast-iron connections to pump, was under £150, so that the town supplies on this system cannot be considered extravagant.

Efficacy of Vaccination.—In his report of the working of the Homerton Small-pox Hospital, Dr. Gayton supplies us with the most recent, as well as most cogent, proof of the marvellous efficacy of vaccination as a prophylactic, and of the utter ignorance and crass stupidity of the people who are induced by paid agitators to lend their names and their uneducated minds to the contest against vaccination. From January 1 to March 7, 1883, during which time the small-pox patients were treated in the Fever Hospital, 62 cases were admitted; of these, 43 were vaccinated, of whom 3 died, or at the rate of 7·0 per cent.; 12 were doubtfully vaccinated, of whom 3 also died, or at the rate of 25 per cent.; and 7 were unvaccinated, of whom again 3 died, or at the rate of 42·85 per cent. From March 7 to the end of the year, 325 patients were admitted—viz., 237 vaccinated, 30 doubtful, and 58 unvaccinated. Amongst these 17, 5, and 25 deaths respectively occurred, or at the respective rates of 7·02, 16·6, and 43·1. It seems, therefore, that the unhappy child who, by the influence of these foolish people, has been deprived of the benefit of vaccination, runs a risk of death from small-pox more than six times greater than the child who has undergone the harmless operation necessary to preserve him against that disease.—*The Medical Press*.

The Antiquity of Mercury.—A recent writer in the *North China Herald* discusses the part played by mercury in the alchemy and *materia medica* of the Chinese. Cinnabar was known to them in the seventh century before the Christian era, and its occurrence on the surface of the earth was said to indicate gold beneath. Their views on the transformation of metals into ores and ores into metals by heat and other means took the form of a chemical doctrine about a century before Christ, and there is now no reasonable doubt that the Arabian Geber and others (as stated by Dr. Gladstone in his inaugural address to the Chemical Society) derived their ideas on the transmutation of metals into gold and the belief in immunity from death by the use of the philosopher's stone from China. Among all the metals with which the alchemist worked, mercury was pre-eminent, and this is stated to be really the philosopher's stone, of which Geber, Kalid, and others spoke in the times of the early Caliphs. In China it was employed excessively as a medicine. On nights when dew was falling a sufficient amount was collected to mix with the powder of cinnabar, and this was taken habitually till it led to serious disturbance of the bowel functions. In the ninth century an emperor, and in the tenth a prime minister, died from over doses of mercury. Chinese medical books say it takes two hundred years to produce cinnabar; in three hundred years it becomes lead; in two hundred years more it becomes silver, and then by obtaining a transforming substance called "vapour of harmony" it becomes gold. This doctrine of the transformation of mercury into other metals is 2,000 years old in China. The Chinese hold that it not only prolongs life, but expels bad vapours, poison, and the gloom of an uneasy mind.

"Let Knowledge grow from more to more."—Alfred Tennyson.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

***All Editorial communications should be addressed to the* Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to delays arise for which the Editor is not responsible.**

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The Editor is not responsible for the opinions of correspondents.

No communications are answered by post, even though stamped and directed envelope be enclosed.

DAISIES.

[1381]—I never had the slightest desire to exterminate daisies anywhere, and I have not the remotest idea how anybody seized with such an unnatural longing could proceed to gratify his or her wicked and destructive tastes. Perhaps the easiest way out of the difficulty would be for the "Disconsolate Female" to aim at acquiring a more reasonable liking for beautiful natural objects, and to correct the mistaken feeling which prefers an artificially smooth lawn to the graceful variety of self-sown herbage.

Grant Allen.

FALSE PERSPECTIVE.

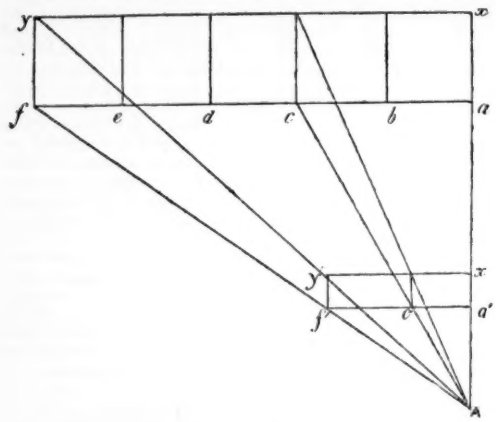
[1382]—It was a grave omission in the elementary works on Perspective not to have pointed out to T. E. (R.) Jones that the appearance of his "Plane of the Picture," and of the lines drawn

upon it, are subject to the same laws of perspective as other objects.

For experiment, if he will arrange his row of equidistant and similar posts against a wall, which may be called the "Plane of the Picture," then trace the outline of each on the wall with chalk, and remove the posts, there will remain a perspective representation in harmony with the recognised rules; and which yet, from its parts being at different distances from the spectator's "station-point," will show the same variations from crude regularity as the original objects themselves. R. R.

[1383]—By returning to the charge, T. E. (R.) Jones proves that this question is not yet satisfactorily disposed of. Does not the solution of the difficulty lie in the fact that a picture containing the element of perspective can only be seen properly from one point—which is technically known, I believe, as the "point of station?"

Of course, the post f (in Mr. Jones's diagram) appears shorter than the post a, "because it is more distant"; but its counterfeit presentment in the picture will also appear shorter for the same reason; and, if properly drawn, exactly in the same proportion.



The accompanying figure is intended to represent the posts in perspective. A a is at right angles to af. The post f will then subtend a smaller angle at A than, for instance, the post c. a' c' f' is the ground-line of the posts as represented in a picture. A is still the position of the observer. It will then be seen that the post f' must be represented as exactly the same length as the post c' in order that their *apparent* sizes may correspond with those of f and c; and the line y' x' must be drawn parallel to the line f' a' in order to *appear* to converge as y x and f a appear to do.

Of course, the post a must be supposed to be towards the centre of the picture; but the field of view would never in practice be made to include so large a lateral angle as twice f A a.

J. H. D.

[1384]—In my letter (1359, August 15th) which appeared in Knowledge, I should have added, "If an observer standing at any point on the line A B parallel to af, proceed to move either to his right or left, still keeping on the parallel line, he will observe the effect described.

Perhaps you will kindly allow me to point out (with a view to setting this question at rest) that if any one who doubts what I have said about the false perspective of rectangular solids, will place himself on the pavement in Gower-street, Lancaster-gate, Portland-place, or some similar street where the window and door lines, &c., are sufficiently even, and then walk along the curbstones until he can just catch sight of the houses in a side street opposite, he will have before him (supposing the streets to be at right angles) two sides of a parallelopiped, whose top and bottom edges trend away (or seem to trend away) to their respective vanishing point.

R. (not "T. E.") Jones.

"MOSES AND GEOLOGY."

[1385]—I have only this morning been made aware of your article in Knowledge of Aug. 15, and must say that it has greatly surprised me. You call upon the members of my committee to furnish you with the names of the eminent scientists who have re-examined my work. I herewith send you them, and also enclose copies of their letters, the originals of which I shall be happy to show you at any time, and as you have attacked me so virulently and charged me with "crass ignorance," you will no doubt feel bound in honour to print these letters in full in your next edition.

You state that my ridiculous blunders have been thoroughly exposed. Permit me to say that I have clearly proved in my replies to my antagonists that I have been on all occasions *misrepresented* and *misquoted*, and in most instances it was quite evident that my opponents had not even read my book.

I would venture to think, from what you have written, that you also have not done so. Therefore I have desired Messrs. Cassell & Co. to send you a copy, and I must beg of you, as an act of justice to me and to the whole scientific world, that you will kindly read at least what I have written upon astronomy, after which I am sure you will be led to do your best to neutralise, as far as lies in your power, the article before me. Samuel Kinns.

[I willingly print Dr. Kinns's letter, and those of his "eminent scientists." I read attentively through a former edition of his book, at the time of its appearance; and will re-read the astronomical portion of the present edition with equal care. Meanwhile, I note that in his printed testimonials his sole *astronomical* authority is Mr. W. T. Lynn (he seems, somehow, to have dropped Mr. Dunkin), a gentleman who has written a nice little book or two, and who occupied a subordinate position in the Royal Observatory for some years. Whether Mr. Lynn was responsible or not for the abnormal refraction business, I do not know. If so, singularly little deference need be paid to his opinion as to the logical value of the rest of the book. If, however, names are to be quoted (like texts) as decisive, it might be curious to speculate what Dr. Kinns thinks of the dicta of one of the very greatest astronomers now living, Sir George B. Airy (with whom Mr. Lynn could scarcely be compared, even by Dr. K. himself), as expressed in his "Notes on the Earlier Hebrew Scriptures," published by Longmans & Co. in 1876. One would also, by the way, like to know how far Dr. Kinns's ideas are endorsed by such members of the staff of the British Museum as Sir Richard Owen, Drs. Günther and Woodward, or Messrs. Carruthers, Butler, Etheridge, and Fletcher?—Ed.]

"THE SCIENTIFIC ACCURACY OF THE BIBLE.

"In reference to the correspondence which appeared some few months ago as to Dr. Kinns' work, 'Moses and Geology,' we trust we may count upon your giving insertion to the accompanying letters which have been called forth by the publication of the Seventh Edition, and bear important testimony to the accuracy of the statement of scientific and other facts in the work. We are very desirous that this act of justice should be done to an author who was subjected to the painful ordeal of so much unfair and injurious criticism, to which it was difficult at the time to give a complete answer. We may add that the cordial reception of the lectures and addresses which Dr. Kinns has continued to give in various towns throughout England, bear witness to the esteem in which he is held.—On behalf of the Committee, we are, Sir, very truly yours, Shaftesbury; R. N. Fowler, Lord Mayor; Thomas Chambers, Recorder; R. Payne Smith, Dean of Canterbury; Henry White, Chaplain in Ordinary to the Queen."

"British Museum, London, April 12th, 1884.

"Dear Dr. Kinns,—Having examined the proof-sheets of the Seventh Edition of 'Moses and Geology,' now in the press, we consider the intrinsic merits of the work as very great, and that you have compiled the scientific, historical, and other facts with much care and accuracy.—Trusting that the book may continue to have the success which it deserves so well, we remain, yours most truly, S. Birch, LL.D., Theo. G. Pinches, Department of Oriental Antiquities, British Museum."

"Royal Astronomical Society, Burlington House, Piccadilly,
"May 12, 1884.

"Dear Dr. Kinns,—At your request I have examined the astronomical portions of 'Moses and Geology' for a Seventh Edition of the work. Great credit is, I think, due to you for the care, diligence, and accuracy with which you have brought the scientific information up to date, as well as for the thorough revision which the book has now again undergone, rendering it still more worthy of the perusal of those who take an interest in its important subject.—Yours sincerely, W. T. Lynn, B.A., F.R.A.S., late Superintendent of the Calculating Department, Royal Observatory, Greenwich."

"Athenæum Club, Pall Mall, S.W., 21st May, 1884.

"My dear Dr. Kinns,—Having examined the proof-sheets of the geological portion of the Seventh Edition of your work, 'Moses and Geology,' I can testify to your having exercised great care and pains in the arrangement and statement of the facts which they contain.—With kind regards and good wishes, believe me, dear Dr. Kinns, yours truly, H. W. Bristow, F.R.S., Senior Director of H.M. Geological Survey."

"1, Bedford-square, W.C., May 14, 1884.

"MY DEAR DR. KINNS,—Having gone over the proof-sheets of the Seventh Edition of your book, 'Moses and Geology'—or, rather, that portion of it devoted to the subject with which I am more familiar, the brain and its wondrous nervous connections—I may say your descriptive matter is all that I can desire it to be, lending a charm and a value to the generally instructive character of your work.—Believe me to remain, yours very sincerely,—Jabez Hogg, M.R.C.S., Consulting Surgeon to the Royal Westminster Ophthalmic Hospital; Fellow of the Medical Society, London, &c."

"97, Highbury New Park, May 15, 1884.

"MY DEAR DR. KINNS,—I have at your request again examined all the Hebrew references in your valuable book, 'Moses and Geology,' and find them quite correct. I humbly believe that you have done immense good by proving the correctness and authenticity of the sacred records, and trusting you will meet with that success which your ardour and pious labour truly deserve, I am, my dear doctor, yours very sincerely, B. H. ASCHER, Rabbi of the United Synagogue."

THE BEST FORM OF TRICYCLE.

[1386]—During my tour along the south coast I saw KNOWLEDGE, and noticed an article on tricycles. I ride a 36-in. "Merlin," and find it most suitable for my own use; but, having formerly ridden a Coventry "Compressus," I thought how near your ideal machine it approaches. Having often ridden with the "Compressus," I know there are few machines that surpass it, only that it requires the rider to get a little forward to get additional weight on the driving-wheel going up hill; and for those who care to have two speeds it can easily be applied. But it mainly dismisses the great point of Large *v.* Small Wheels, inasmuch as the large wheels carry the weight at level running, while the small one does the driving.

I think if you would give the machine in question a little study and fair trial, you will be disposed to pronounce it second to none of chain-driven tricycles.

Have you tried the new "Merlin," and what is your opinion of it? H. A.

MIND AND BRAIN.

[1387]—If not encroaching too much on your valuable space, in reply to your editorial note on Huschke's dictum, that the vibrations of ether do not become colour until they are transmitted to the brain." I would rather put it thus:—"The phenomenon of colour is perceived" by the brain, through the eye and connecting nerves, and there transformed into the idea or thought expression—viz., colour. Nevertheless, the phenomenon of colour would still exist or be formed in fact, whether we could see it or not, or whether we called it colour or any other name. So I take Huschke to mean that the vibrations of stimuli, transmitted from within or without to the brain, are there transformed into thoughts or ideas by the self-acting molecules of the brain, whatever names we may give them.

In short, like the vibrations of light are transformed—say by a prism into colours—so are the vibrations of stimuli passing through our nerves and the brain transformed or modified into thoughts or ideas. F. W. H.

[Just so. External stimuli may be "transformed into" thought by the molecular vibration of the brain; but the contention of Büchner and Huschke is that such vibrations *are* thought, which to ordinary minds is simply inconceivable.—ED.]

THE TERMS "PRIMARIES" AND "SECONDARIES" AS APPLIED TO COLOURS.

[1388]—In a recent issue of KNOWLEDGE there was some reference to what have been—under the nomenclature founded on erroneous conceptions regarding colour—termed *primaries* and *secondaries*, or *complementaries*. Colours are still regarded, and spoken of, as if they had external existence. Persons, even those esteeming themselves "scientific," have constantly to be reminded that colours are but sensations, or appearances, excited in us by vibrations of different periodicities. Externally to sense the vibrations which excite all the different sensations of light (colour) in us are simply vibrations without luminosity or colour. "The light is within us." Now, we cannot consistently speak of *primary* and *secondary* sensations. The complementary colours, as they are called, are not the effects of mixed sensations, but of the combined action of different wave lengths. It matters not whether vibrations be produced by the prismatic spectrum or by pigments, it is by means of vibrations alone that vision is effected. Let, for the sake of argument, the wave length of red be represented by 14, and blue by 9; then, if the two vibrations simultaneously affect the same portion of the retina, we shall experience a third sensation of colour—the result of their combined action. Correctly speaking, it is not a colour that has a *complementary*, but a vibration.

In my little work upon "Light" I have expounded the principle of complementary vibrations—a principle which the late Mr. William Spottiswoode pronounced to be a sufficient and complete explanation of the phenomena. But to our point, the prism does not refract colours, but vibrations; externally to the eye, there is, therefore, nothing but differentiated vibratory action, and by this medium all our varied sensations of sight are affected. On a future occasion, if permitted, I will advance reasons why it is also inconsistent that the terms *primaries* and *secondaries* should be applied to differentiated vibratory action. W. CAVE THOMAS.

[Carrying out the principle enunciated in the above letter in its integrity, I have no business to talk about the object on which I am writing as "a table." What—if I rightly apprehend Mr. Cave Thomas—I ought to say is that I have certain sensations which I call brownness, blackness, hardness, resistances, extension, the scent of Morocco leather, &c., the sum of which make up my concept. I have myself said (in a note to letter 1362, p. 144) that the ethereal vibrations do not become *colour* until they have been transmitted through the eye and optic nerve to the brain; but, alike for the purposes of science and common sense, we treat colours as objective realities.—ED.]

LETTERS RECEIVED AND SHORT ANSWERS.

THE HONORARY SECRETARY OF THE CORK LITERARY AND SCIENTIFIC SOCIETY is requested kindly to read the paragraph which concludes the first column on p. 62, and which has recently appeared on other occasions in this journal.—E. P. The whole thing is a matter of common sense. Mechanical pressure is admittedly a—or rather *the*—*vera causa* of such a movement, and Faraday's contention was that pressure was innocently exerted by the operators. His apparatus was so constructed that when pressure was applied the index moved, and when such pressure ceased to be applied it remained stationary. With the result you are familiar. Hermann, the conjurer, brings two live rabbits down into the stalls, and, holding them up by the ears in the very midst of his audience, strokes them into one. On the principle of *Parsimonia principiorum*, I find a ready explanation of this in the conjurer's proficiency in sleight-of-hand. Suppose, though, that some one chose to assert that the spirit of (say) Hermann's deceased wife's sister had removed the second rabbit, or incorporated it with the first, and that you or I were to suggest a plan (such as catching the performer by the wrist at a particular stage of the trick) by which the disappearance of rabbit No. 2 was prevented. Are we to be told that because the performer failed to unite the rabbits, our device "leaves the question just where it was? Without the postulate of Parsimony it is migatory, and with that postulate it is superfluous?"—SIDNEY WOODFORDE. For the dozenth time I have nothing to add to what I wrote on p. 58 of Vol. V. of KNOWLEDGE. I really must beg you (and scores of correspondents who persist in sending me stamped and directed envelopes for private replies) to read, mark, learn, and inwardly digest the sentence in capital letters which concludes the heading of the correspondence columns.—L. G. R. See answer to E. P. above.—C. H. JOHNS. You will find the lines you quote in Wordsworth's "Tintern Abbey."—THE SECRETARY OF THE BOW AND BROMLEY INSTITUTE is requested to be good enough to read the first reply above.—W. W. S. The "Monthly Notices" of the Royal Astronomical Society are published by Williams & Norgate, London. I do not know the price to the public. All information with regard to the publications of the Liverpool Astronomical Society may be obtained on application to W. H. Davies, Esq., F.R.A.S., 55, Great Newton-street, Liverpool.—ANONYMOUS (Sunderland). Our advertising columns are open to you.—JOHN HAMPDEN. Some one has been hoaxing you. Does not your own common sense suffice to show you that, were the earth flat, no intermediate stations whatever would be needed between Wimbledon and Portsmouth?—SIGMA. It appears as though you were incapable of realising the *meaning* of Infinity. How can you possibly add—or subtract—from Infinity, or one infinite quantity from another; or conceive a circle with an "infinite" radius? As for your notions of equating two expressions each of them = nothing; a very old mathematical joke will serve to illustrate where that will land you. Let $a=b$: then $a^2=ab$ and $a^2-b^2=ab-b^2$: or $(a+b)(a-b)=(a-b)b$ or $a+b=b$: *i.e.* $2a=a$ or $2=1$!—C. FREDERICK WILKINSON.—Thanks for your interesting extract, which is marked for insertion.—CHAS. ALDRIDGE. The Editor is nearer to you than you imagine. Your letter will be forwarded.—ERIMUS. *Does* "every ninth wave rush in with greater volume and force than any of the others?"—DR. J. MURRAY MOORE. How could a star which appeared in Virgo, by any conceivable possibility, reappear in Cassiopeia? A new star did blaze out in Cassiopeia from Nov., 1572, to March,

XUM

1574, and Tycho Brahé determined its place with some accuracy. There is a minute telescopic star (No. 129 of d'Arrest's Catalogue) within 1′ of this position, which was discovered to be slightly variable by Hind and Plummer in 1873. There is no record of the appearance of any new star in Virgo, B.C. 4; but that very doubtful authority, the Bohemian astronomer, Cyprianus Leovitius, asserts that he found, in a manuscript, a record of the appearance between Cepheus and Cassiopeia in 945, and again, in the same neighbourhood, in 1264, of a new star, which it has been thought may have been Tycho's. Assuming such conjecture to have been correct, the star should have reappeared in 1880. "Mercator" is wrong, *in limine*, in his dates, and quite obviously ignorant of the very rudiments of astronomy, or he could never have imagined two stars, separated by an arc of more than 120° in the heavens, to be one and the same object.

Our Chess Column.

By Mephisto.

"DEAR SIR,—I have been much interested in the game published in this week's KNOWLEDGE. But, on going over the moves suggested as a probable continuation, I cannot see that White can really force the game. I enclose a rough analysis to show you where my difficulty lies. It seems to me that 33. Kt to K7 (ch) is a complete answer to 33. P to Q6. After 32. Kt × Kt, Black has a Rook to the good, and therefore can afford a considerable sacrifice to beat off White's present attack. I tried 33. R × P (ch), but the White King can escape. I cannot see any escape after 33. Kt to K7 (ch).

"I think White's best play is to get his B to Q3 *before* playing P to Q6. Thus 33. B to R7 (ch) / K to R sq. 34. B to Q3 (ch) / K to Kt sq. 35. P to Q6. But even then Black may follow with 35. Kt to K7 (ch), and I don't think White can dare capture the Knight. Then, again, if Black can get one more check and then attack the White Queen with Kt, he can safely challenge the exchange, or can sacrifice his Knight to give his Queen time to take the QP and retire to defend KBP.

"Altogether, the position is such a good one, that I think you would interest other readers as well as myself if you would analyse it for us a little further. "W."

We agree with our correspondent that the position is an interesting one. We ought to have been a little more explicit in our remark about 32. Kt × Kt. It is all-important in such critical positions to find the correct way of playing, as without it a sure game may be lost. If in this position 32. Kt × Kt then we must first avoid losing the important B by a ch with Kt on Kt6; we, therefore play 33. B to R7 (ch) / K to R sq. The B being now very well posted, we proceed to 34. P to Q6, which valiant P the Q cannot take on account of a mate in three. But if 34. Kt to K7 (ch) / K to R sq. 35. Kt to Kt6 (ch) / 36. K to R2. To avoid the threatened mate in three Black has nothing better than 36. Kt to B8 (ch) 37. R × Kt(a) / Q × P (ch) 38. K to R sq. / Q to B2 (best).

Position after White's 32nd move.

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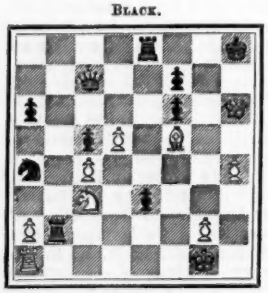

WHITE.

We did not play R to B4 as Black could have replied with Q × R, followed by K × B remaining with two R's against the Q and a better game. Now White cannot do better than play 39. B to Q3 (ch) / K to Kt sq. 40. Q to R7 (ch) / K to B sq. 41. Q to R8 (ch) / K to K2 42. Q × P (ch) / K to B sq. 43. Q × R and White wins.

(*a*) This leads to a win if correctly followed up. A more decisive yet simpler move is 37. K to R3, which wins at once, as Black cannot check with the (Q) on account of B coming on B5 with a check. If Q × P 38. B to Kt6 (ch), K to Kt sq. 39. Q to R7 (ch), K to B sq. 40. Q × P mate, or if Q to R2, the Q mates in two moves on R8.

PROBLEM No. 126.

By I. G.

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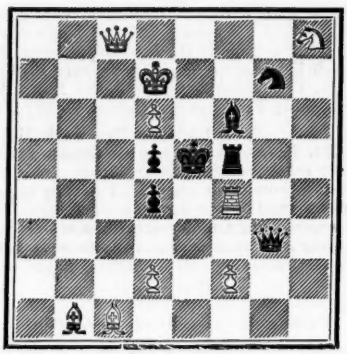

WHITE.

White to play and mate in two moves.

SOLUTIONS.

PROBLEMS BY T. G. p. 168.

I.

1. B to QB3	1. Q to K Kt2
2. K to B8 (ch)	2. Q × Q
3. B to B7	mate

II.

1. Q to Kt7	1. Q × Q
2. P × Q	2. K to R sq.
3. P to Kt8 (ch) (Q)	mate.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

Jas. G. Reeve.—See above letter. Solution incorrect as 1. K to R sq.

Correct solutions received Problem No. 124.—Fred Kingley, J. K. Milne, H. A. N., M. T. Horton, A. W. Overton.

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